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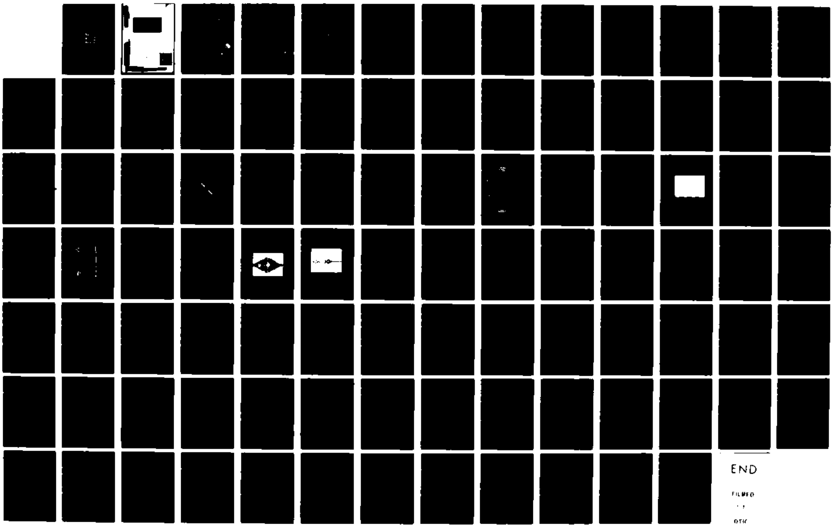

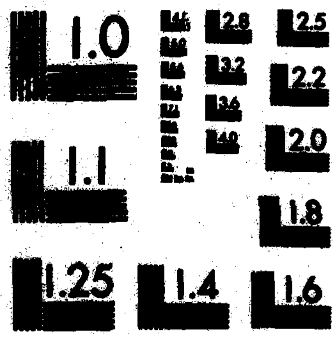

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ANNUAL PROGRESS REPORT

and

REPORT OF SIGNIFICANT ACCOMPLISHMENTS

Joint Services Electronics Program

Contract N00014-75-C-0632

1 April 1981 through 31 March 1982

G.L. Report No. 3411

Edward L. Ginzton Laboratory
Stanford University
Stanford, CA 94305

Submitted by A.E. Siegman on behalf
of the faculty and staff of the
Edward L. Ginzton Laboratory

April 1982

Edward L. Ginzton Laboratory
W.W. Hansen Laboratories of Physics
STANFORD UNIVERSITY

ANNUAL PROGRESS REPORT

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REPORT OF SIGNIFICANT ACCOMPLISHMENTS

JSEP CONTRACT NO. N00014-75-C-0632

CONTENTS

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Ginzton Laboratory Report No: G.L. 3411

SECTION I

INTRODUCTION AND SUMMARY

This is the first annual progress report for the JSEP program in the Ginzton Laboratory at Stanford University, for year number one of the current three-year cycle, running from 1 April 1981 to 31 March 1982. The research activities during this period were organized into five Work Units, as outlined in our original proposal, covering the following topics:

Work Unit #81-1. Interactions of Acoustic and Optical Waves With Domains in Ferroic Fibers and Bulk Materials, by Professor Bertram A. Auld.

Work Unit #81-2. High-T_c Josephson Junctions, by Professor Malcolm R. Beasley.

Work Unit #81-3. Optical and Nonlinear Optical Studies of Single Crystal Fibers, by Professor Robert L. Byer.

Work Unit #81-4. Applications of Integrated Circuit Technology to Acoustic Surface Wave Devices, by Professor Gordon Kino.

Work Unit #81-5. Picosecond Raman Studies of Electronic Solids, by Professor Anthony E. Siegman.

In broad terms, this has been a productive and successful year, with various of these Work Units operating in different parts of the typical research project cycle.

In the case of Work Units Nos. 3 and 5 (Byer and Siegman) the year has been one primarily of apparatus design and construction, in preparation for significant research accomplishments in the next coming years. Similarly for Work Unit #1 (Auld) the year's efforts have gone toward laying theoretical foundations, as well as preparing experimental apparatus, for studies of new nonlinear ferroelastic materials. Professors Beasley and Kino (Work Units #2 and #4), in a somewhat later phase of the cycle, have been collecting the benefits of earlier preparation, and producing significant advances in their respective areas of high-temperature Josephson junction technology and combined semiconductor plus SAW technology.

One project (Work Unit #4) is being successfully concluded and replaced by a new direction by Professor Kino. Otherwise, the research activities generally followed the plans laid down in the basic three-year proposal, and we anticipate a productive continuation of these activities into the second year.

SECTION II

REVIEW OF SIGNIFICANT ACCOMPLISHMENTS

A brief review of significant accomplishments during the past year for each of the current Work Units is given in this section. More details of each of these projects will be found in the longer Annual Progress Reports for each of the Work Units, which follow this section.

Work Unit #1: Interactions of Acoustic and Optical Waves with Domains in Ferroic Fibers and Bulk Materials, by Professor Auld.

On Professor Auld's project, for the first time a complete basic analysis and classification of nonlinear elasticity in proper ferro-elastic materials has been completed and submitted for publication in a major basic physics journal.

Work Unit #2: High-T_c Josephson Junctions, by Professor Beasley.

On Professor Beasley's JSEP project the application of step-edged patterning to the fabrication of high-T_c superconducting SNS microbridge Josephson junctions continues to represent a major break-through in the goal of a high operating temperature superconducting circuit technology. This approach has now been successfully applied with Nb_3Ge, the highest transition temperature superconductor known to date. In addition, dc superconducting quantum interference devices (i.e., dc SQUID's) made with these functions have demonstrated the fundamental advantages of using high-T_c materials, namely, high operating temperatures and potentially superior performance at low temperatures. Specifically, our SQUID's exhibit useful operating characteristics at temperatures as high as $T > 15K$ and nearly quantum limited sensitivity at 2K.

Work Unit #3: Optical and Nonlinear Optical Studies of Single Crystal Fibers, by Professor Byer.

On Professor Byer's project the design of a laser-heated crystal growth facility to produce greatly improved single crystal optical fibers has been completed, and construction of this growth apparatus is now well under way.

Work Unit #4: Applications of Integrated Circuit Technology to Acoustic Surface Wave Devices, by Professor Kino.

On Professor Kino's project the marriage of silicon integrated circuit technology and surface acoustic wave (SAW) technology has been successfully accomplished with the construction of a novel, programmable signal processing device called the "SAWFET."

Work Unit #5: Picosecond Raman Studies of Electronic Solids, by Professor Siegman.

On Professor Siegman's project a Raman spectrum of silicon has been taken using picosecond laser pulses, and found to differ significantly from cw Raman spectra on the same sample.

SECTION III

ANNUAL PROGRESS REPORTS

Unit 81-1

NONLINEAR INTERACTIONS OF ACOUSTIC WAVES

WITH DOMAINS IN FERROIC MATERIALS

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A. Introduction

Ferroic materials (ferromagnetic, ferroelectric and ferroelastic) have the unique property of exhibiting switchable configurational states with distinct macroscopic material properties. These states are not only switchable but also have a latching property, or memory. That is to say, once the material is switched it remains in the switched state until further addressed by an electric or mechanical signal. Furthermore, different regions of a single specimen of ferroic material may be in different configurational states. These regions of distinctly different configurational states, called domains exhibit distinct physical properties and the boundaries between domains, or domain walls, are therefore surfaces of abrupt change in material properties. The existence of switchable and latching boundaries of this nature provide a basis for a variety of optical and acoustical devices such as diffraction and phase matching gratings, directional couplers, filters and memory stores. The goal of this project is to study the nonlinear interaction of acoustic waves with domains (primarily in ferroelastics and ferroelectric-ferroelastics) with a view to gaining a better understanding of the physics involved and then evaluating the potential of such materials for new device applications.

The general research plan focuses on (1) nonlinear elastic properties of ferroelastic materials, particularly the influence of phase transitions and domain walls on these nonlinearities, (2) the influence of domain wall structure on acoustic harmonic generation, rectification and parametric processes, and (3) interactions of domain walls with static strains generated by nonlinear elastic rectification of an acoustic wave. Except for gadolinium molybdate (GMO), ferroelastic crystals are not available in the large imperfection-free samples needed in the standard traveling wave methods used for measuring third order elastic constants. An alternative resonator method is being developed for second harmonic and rectification measurements in small thickness mode plate resonators. Such measurements are of basic importance in a determination of the feasibility of moving ferroelastic domain walls by means of a rectified acoustic field in a resonator.

The project is actively correlated with the National Science Foundation's fiber crystal growth program at the Stanford Center for Materials Research (CMR). That work is concerned with growth of all types of single crystal fibers and study of their physical properties — optical, elastic and mechanical. Of particular interest in this collaboration is the growth of ferroelectric and ferroelastic crystal fibers, such as lithium niobate and gadolinium molybdate, and experimental investigations of acoustic wave propagation and ferroelastic domain wall injection in fibers.

With regard to potential device applications of the materials and phenomena under study, these all involve the use of periodic arrays of grating, created and aligned by either the nonlinear acoustic method referred to above or electrical poling techniques above the Curie temperature. Specifically of interest are acousto-optic diffraction gratings for signal processing, phase matching for collinear phase matched optical harmonic generation and gratings for distributed feedback lasers.

numerical estimates were made of the third order constants for NPP, one candidate for our experimental work.

(ii) Measurement of Nonlinear Elastic Effects

As noted in the Introduction, measurement of third order elastic constants in ferroelastics by second harmonic generation is made more difficult by the general unavailability of high quality crystal samples of sufficient size for traveling wave measurements. Because of this, we have been developing a technique for measuring these constants in small elastic resonators. The first experiments of this kind, described in publication (1) listed at the end of this report, were performed on the length extensional mode of an elastic rod at low frequency ($\approx$ 50 kHz). In this geometry, interpretation of the results is made difficult by the complicated nature of the mode fields, even at low frequencies. Another disadvantage is the inconvenience of fabricating rod samples. For these reasons, we have converted to small plate thickness resonators operating near 10 MHz. Such resonators are easy to fabricate and analyze, even in the low crystal symmetries typically found in ferroelastic compounds. Since an important goal of our investigation is nonlinear generation of static strains capable of displacing ferroelastic domain walls, we must fabricate each plate resonator with faces parallel to an appropriate domain wall plane in the chosen material and pick a resonant mode having the proper strain components to nonlinearly generate the desired component of static strain. For such crystal orientations the modes are generally neither pure longitudinal nor pure transverse, a situation not previously considered in elastic second harmonic generation. The problem of analysis is rather involved but can be treated for all crystals and orientations of interest, as illustrated in publication (2) listed at the end of this report. In highly anisotropic materials the strength of the second harmonic excitation is given by a combination of secor . and third order elastic constants, from which it is difficult to extract the constants themselves. However, it can be shown that the static field produced by rectification has a strength determined by the same combination of constants as the second harmonic. This means that the desired rectification effect is measured directly, giving more accuracy than an individual determination and combination of the separate constants involved.

The laser probe elastic second harmonic measurement technique reported in publication (1) provides an absolute measurement of the fundamental and second harmonic amplitudes, similar to that performed with the conventional capacitive probe technique, but in a geometry more suitable for measurements at low and high temperatures. One difficulty in using the laser probe for this purpose arises from the fact that phase modulation of the laser beam by the fundamental frequency vibration produces, itself, second harmonic amplitude modulation sidebands. These must be then distinguished from the phase modulation sidebands generated by the second harmonic component of the elastic vibration. In the publication cited, this separation was effected by imposing a second phase modulation on the laser beam, using an EO modulator. Frequency mixing in the photodiode subsequently converted the desired second harmonic phase modulated sidebands to amplitude modulated sidebands at a low difference frequency, and the undesired amplitude modulated signal to a difference frequency phase modulated signal. The low frequency AM sidebands were then detected with a square law diode, which is insensitive to the phase modulation.

This modulation heterodyne scheme has the further advantage of converting the fundamental and second harmonic elastic vibration signals to a nonharmonic frequency relationship, eliminating the possibility of errors due to harmonic generation in the circuitry. However, its implementation was found to be inconvenient because of the need to insert an EO phase modulator in the laser beam, and a new all-electronic system was devised.

As it finally evolved, this system passed the output of the photodiode through an amplitude modulator to provide the frequency-mixing function described above. In this arrangement the desired elastic second harmonic signal remains in the form of a phase modulation; and the spurious amplitude modulated second harmonic signal is stripped off with a hard limiter, which also serves to reduce plasma oscillation amplitude noise from the laser. With these new improvements the system has proved to be much easier to align, more stable, and less noisy.

Plans call for the new probe system to be tested for accuracy on a variety of crystals with known nonlinear constants (e.g., Y-cut lithium niobate, Z-cut lithium niobate, Y-cut quartz) before attempting measurements on GMO and NPP. The electronics will also be modified to permit optical measurement of the rectification effect.

(iii) Crystal Growth and Material Characterization

The crystal growth part of this project has this year taken the form of providing some financial support for the efforts of the Crystal Technology Group (Dr. R. Feigelson) to grow single crystal fibers of GMO. This crystal growth activity, performed in collaboration with the NSF Fiber Thrust Program, includes fabrication of a controlled-atmosphere chamber for the laser melting and pulling unit, tests performed on hot-pressed powder seeds with molybdenum enrichment, and extensive diagnostic tests of the GMO samples produced.

The project is also closely linked to two fiber materials characterization projects under the NSF Thrust Program: (1) an investigation of fiber acoustics, designed to measure fiber elastic properties by resonating short lengths of fiber; and (2) a study of domains in ferroelastic fibers and methods for mechanically injecting domains into a fiber in a controlled manner.

C. <u>Publications and Papers</u>

(1) B. A. Auld, S. Ayter, M. Tan, and D. Hauden, "Filter Detection of Phase-Modulated Laser Probe Signals," Elect. Lett. 17, 662 (September 1981).

(2) B. A. Auld and M. M. Fejer, "Elastic Nonlinearity and Domain Wall Motion in Ferroelastic Crystals," Ferroelectrics 38, 931 (1981).

(3) P. Toledano, M. M. Fejer, and B. A. Auld, "Nonlinear Elasticity in Proper Ferroelastics," Phys. Rev. (submitted for publication).

Unit 81-2

HIGH-T_c SUPERCONDUCTING WEAK-LINK JOSEPHSON JUNCTIONS AND CIRCUITS

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A. Research Plan and Objectives

The underlying, long-term objective of this program is to explore the feasibility of high-T_c and/or hard Josephson junction superconducting thin-film circuits; to establish the relevant physics, fabrication procedures, and operating characteristics of such devices; and hopefully to lay the ground work for a superconducting integrated circuit technology based on these materials. This objective requires the development of practical high-T_c and/or hard Josephson devices and also the passive circuits elements necessary for a complete circuit technology. Success in this program would lead to devices capable of operating at substantially higher temperatures (~10-15 K) and/or more rugged circuits resistant to damage due to thermal cycling, handling, and hostile field environments.

Toward this general objective, we have been developing superconducting weak-link (i.e., non-tunneling) Josephson junctions using refractory and high-T_c superconducting materials and by necessity thin-film deposition, microlithography, and processing technologies suitable for such materials. Specifically, we have been concentrating our efforts on the A15-type superconductors, for example Nb_3Sn ($T_c \approx 18$ K) and Nb_3Ge ($T_c = 23$ K) with related work on elemental Nb($T_c = 9$ K) in order to more easily test some of our fabrication techniques.

From the theoretical point of view when considering refractory and high-T_c superconducting materials, the most attractive type of weak-link Josephson junctions appear to be planar SNS (superconductor/normal metal/superconductor) or SSemiS (superconductor/semiconductor/superconductor) bridges, although it must be noted that granular superconducting weak links do show interesting performance, although no satisfactory theoretical explanations have yet appeared. In this program, we are focusing on SNS bridges. These bridges are like the usual SSS superconducting microbridges but where the bridge region itself is a normal metal while the banks are superconductors. The rationale for such devices is that by making the bridge region itself from a normal metal (e.g., Cu, Au, or Ag) one can circumvent the extremely small (< 100 Å) bridge dimensions theoretically required to obtain ideal Josephson behavior in a totally superconducting high-T_c bridge. In such SNS bridges, the dimensions need only be submicron and ideal Josephson behavior should be available over the entire temperature range $0 < T < T_c$.

To achieve such structures in practice, we have been using electron-beam evaporation combined with "step-edge patterning" to define the length of the bridge as illustrated in Fig. 1. At the same time, we have been developing theoretical models for such devices based on the Usadel, Ginzburg-Landau and Time-Dependent-Ginzburg-Landau Theories of Superconductivity.

B. Progress and Accomplishments

As reported last year, the successful implementation of the step-edge patterning approach to making high-T_c SNS microbridges appears to have solved the two basic problems we had previously encountered in attempting to make such devices. First, it allows the fabrication of very short bridges in a controllable way. Second, since the bridge length is defined without etching, it permits one to put the normal metal on top where it can be deposited on the more favorable (upper) surface of the superconductor, thus avoiding the deterioration of the normal metal film experienced previously when it was necessary to heat the film to high temperatures in order to deposit a good superconducting film on top. Moreover, the approach is a generic one and has now been successfully applied to Nb, Nb_3Sn and Nb_3Ge. The $Nb_3Ge/Cu/Nb_3Ge$ bridges have exhibited well-defined robust Josephson behavior from 2 K up to 16.5 K — our best result to date. A superconducting quantum interference pattern and the RF-induced AC Josephson steps exhibited by one of our devices at $\sim$ 15 K are shown in Fig. 2. They are nearly ideal.

During the past year, we have begun to incorporate these devices into simple circuits. In particular, we have successfully made small area dc SQUID's that operate from 2 to 16 K, thus demonstrating the viability of a high operating temperature SQUID technology based on our devices. Input coils have not yet been fabricated, however. Equally important, we have shown that these SQUID's also hold promise for being superior devices at low temperatures. Specifically, in their first test our SQUID's demonstrated noise characteristics nearly as good as the best reported in any device. As seen in the Table, at 2.2 K the energy sensitivity per unit bandwidth of our SQUID's is $\sim$ 3h where h is Planck's constant. In short, our attempts to incorporate the high-T_c superconductors in Josephson junction devices appear now to be bearing considerable fruit. Future efforts will be aimed at fully characterizing these devices and trying to improve their basic characteristics.

C. <u>Publications (under this JSEP Program)</u>

Previously Reported

1. R.B. van Dover, R.E. Howard, and M.R. Beasley, "Fabrication and Characterization of S-N-S Planar Microbridges", IEEE Trans. on Magnetics <u>MAG-15</u>, 574 (1979).

2. R.B. van Dover, A. de Lozanne, R.E. Howard, W.L. McLean and M.R. Beasley, "Refractory Superconductor S-N-S Microbridges", Appl. Phys. Lett. 37, 838 (1980).

Recently Published

3. M.R. Beasley and C.J. Kircher, "Josephson Junction Electronics: Materials Issues and Fabrication Techniques", in Superconductor Materials Science, edited by S. Foner and B.B. Schwartz (Plenum Publications Corp., 1981), pg 605.

4. R.B. van Dover, A. de Lozanne and M.R. Beasley, "S-N-S Microbridges: Fabrication, Electrical Behavior and Modeling", J. Appl. Phys. 52, 7327 (1981).

5. A. de Lozanne, M. Di Iorio and M.R. Beasley, "Properties of High-T_c SNS Microbridges", presented at the LT-16 Conference, Los Angeles, California, August 1981, Physica 108B, 1027 (1981).

Impending Publications

6. M.R. Beasley, "Material Science of Josephson Junctions", to be presented at 1982 IEEE International Electron Devices Meeting, San Francisco, California, Dec. 13-15, 1982.

7. A. de Lozanne and M.R. Beasley, "Time Dependent Superconductivity in SNS Bridges: An Example of TDGL Theory", chapter in Nonequilibrium Superconductivity, D.N. Langenberg and A.I. Larkin, editors (North-Holland Pub. Co., Amsterdam, The Netherlands).

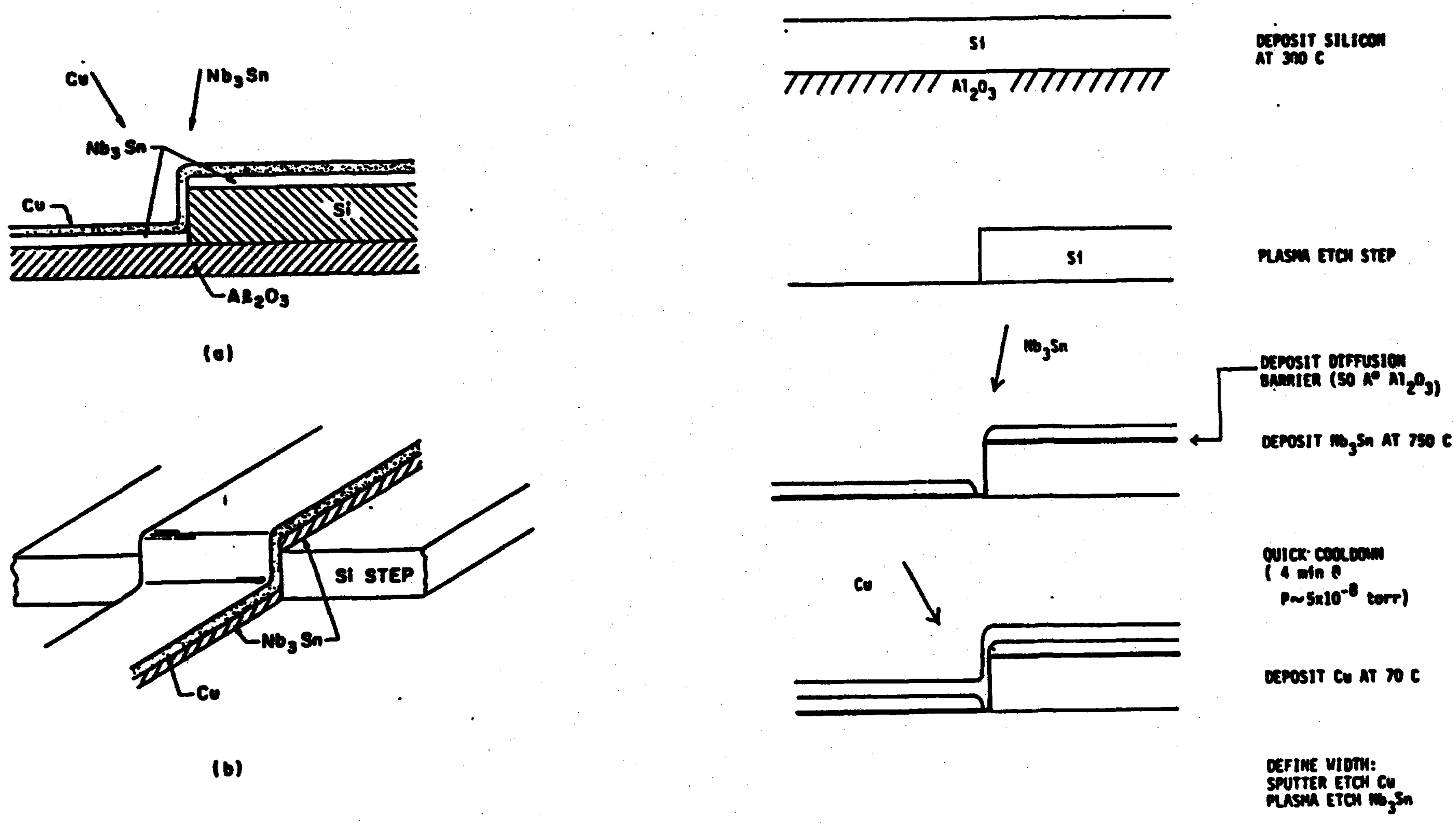
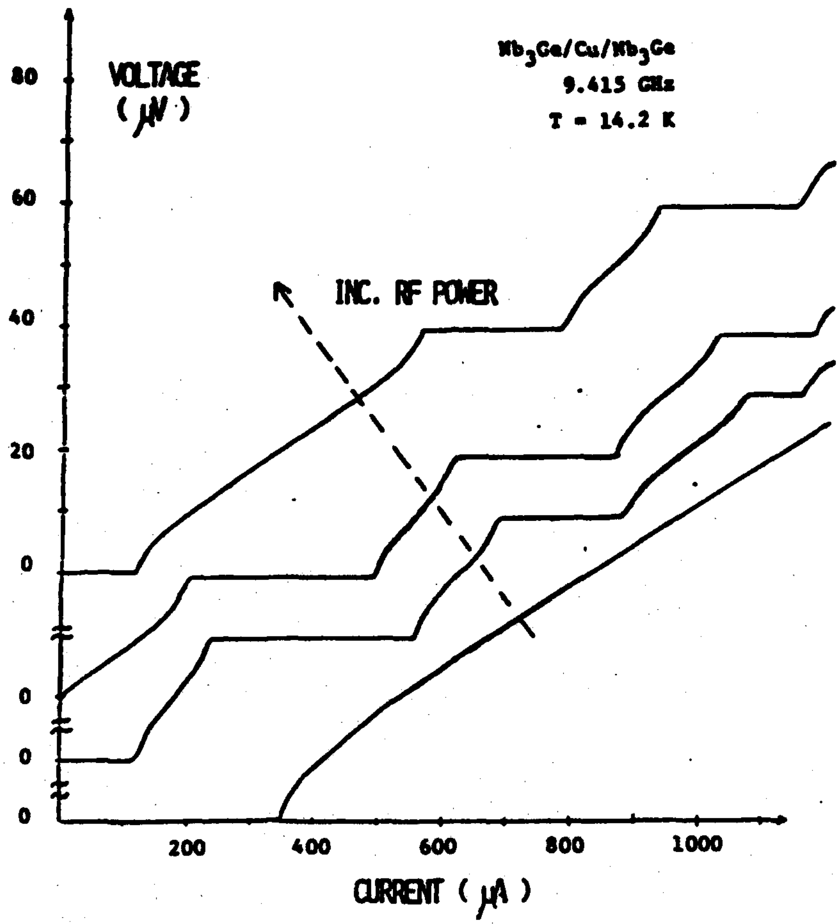


FIG. 1--(a) Schematic of our high-T_c SNS microbridge Josephson junctions.
(b) Processing steps for step-edge junctions.



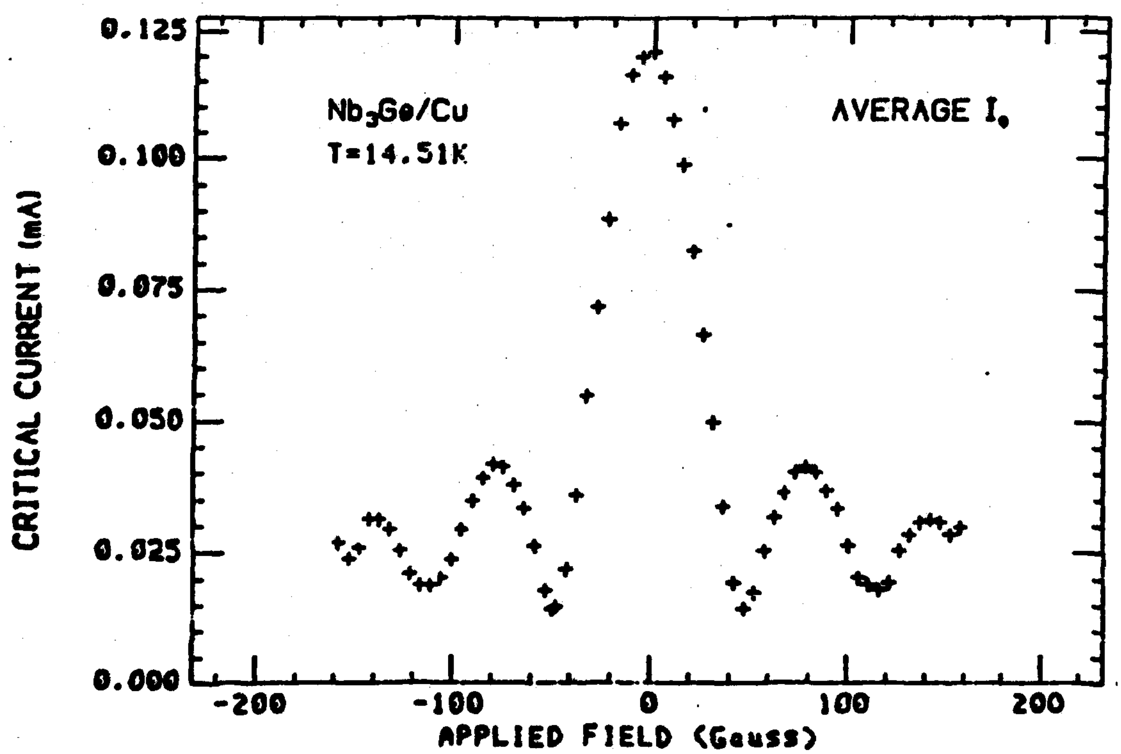


FIG. 2--RF-induced AC Josephson steps and magnetic diffraction pattern of a $Nb_3Ge/Cu/Nb_3Ge$ SNS bridge at $\simeq$ 15K.

TABLE

Noise characteristics of a dc SQUID.

		FREQUENCY	
		10 KHz	100 KHz
	4.2 K	16	10
TEMPERATURE	2.2 K	3	3
	1.8 K	--	3

All measurements are in units of h, with an uncertainty of about ±1.

Measurements courtesy of R. Koch, University of California, Berkeley.

Unit 81-3

OPTICAL AND NONLINEAR OPTICAL STUDIES OF SINGLE CRYSTAL FIBERS

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This project is concerned with the growth of single crystal fibers, the evaluation of their linear and non-linear optical properties, and the development of optical and nonlinear optical fiber devices. The motivation for this study is the variety of applications made possible by the unique combination of fiber geometry and single crystal material properties. Our interest center on devices that take advantage of the enhanced efficiency of nonlinear interactions in guided wave geometries. For example, our calculations show that frequency doubling of 1.06 µm in a 5 cm long 25 µm diameter $LiNbO_3$ fiber would proceed with 50 times the efficiency of a bulk 5 cm confocally focused interaction. The improvement is even more striking if the potential for periodically poling $LiNbO_3$ fibers is exploited. If such a "quasiphasematching" scheme were implemented, another 20 fold improvement in efficiency would be realized, with an overall 100 X enhancement over the bulk interaction.

Recent developments in crystal growth and diode laser technology have given new impetus to our efforts. The growth of "damage free" lithium niobate[1] greatly enhances the possibilities for nonlinear interactions involving visible wavelength. Recently demonstrated 100-200 mW diode lasers,[2] together with suitable $KNbO_3$ fibers, would constitute small, efficient 10 mW 400 nm sources that could displace He-Cd lasers in many applications. These diode lasers are also attractive as pumps for cw parametric oscillators and as sources for frequency differing to produce tunable IR.

While we have emphasized nonlinear interactions in this discussion, the potential also exists for interesting active devices, e.g. Nd:YAG fiber amplifiers and oscillators, and passive devices, e.g. sapphire IR light guides.

The efficient realization of these sorts of devices, particularly those involving phase-matched processes, requires the growth of fibers with good optical and structural uniformity. Our calculations show that diameter variations must be in the range of 0.1 to 1% for fibers to be useful in typical nonlinear processes.

The focus of our efforts in this contract period has been the design and construction of fiber growth apparatus capable of meeting these diameter control criteria. Our short term goal is the completion of this apparatus and developing the techniques necessary to grow good quality fibers. Once we obtain good fibers we will characterize their waveguiding properties, and then demonstrate efficient $x^{(2)}$ and $x^{(3)}$ interactions. These topics are discussed in more detail in the remainder of this report.

PROGRESS AND ACCOMPLISHMENTS

A. Fiber Growth

In past reports we have discussed the two phases of our effort at Stanford to grow high quality fibers. A first generation growth apparatus was completed in autumn 1980 by a group under R.S. Feigelson at the Center for Material Research. Over the past two years they have obtained single crystal fibers of a variety of materials, including $LiNbO_3$, Al_2O_3, Nd:YAG, YIG, $Gd_2(MoO_4)_3$, $CaSc_2O_4$ and Y_2O_3:Eu. The major problem with this system is the unacceptable level of diameter control thus far obtained.

Based on the experience gained with this first generation device, we have designed a second generation system incorporating a number of significant improvements. While we are continuing to cooperated with the CMR group in correcting the problems in their system, we have focused our efforts in the past year on the design and construction of our second generation apparatus.

The growth technique employed in both systems is miniature pedestal growth. The tip of a 0.5 mm diameter source rod is melted with a focused CO_2 laser. A seed crystal is dipped into molten lead, then withdrawn at a constant rate to pull the fiber. The diameter reduction from feed rod to fiber is determined by the ratio of pull to feed rates.

To meet the stringent uniformity conditions required for a useful fiber, it is necessary that the pull and feed speeds, the laser power and the position and size of the focal spot all be accurately controlled. In addition, the growth zone should be isolated from perturbations due to the ambient conditions. Figure 1 is a block diagram of the system we have designated to meet these criteria.

The heat source is a 20 watt waveguide CO_2 laser with active thermal cavity stabilization. The laser has good beam pointing stability and open loop power stability in a 1 Hz bandwidth of ~ 0.5%. To reduce the power fluctuations by another order of magnitude and extend the control bandwidth to 1 kHz, we monitor ~ 1% of laser output with a temperature stabilized pyroelectric detector, and feed back to the current control of the laser power supply. In order to maintain maximum stability, the output of the laser is maintained at a constant value near its maximum, and attehuated externally to the power necessary for growth.

To achieve a uniform temperature around the circumference of the molten zone, the laser beam should be brought to an axially symmetric focus. The length of the molten zone should be on the order of a fiber diameter for stable growth. Thus, a tight focal spot is necessary for the growth of small (~ 25 μm diameter) fibers. To meet these criteria we have designed the novel optical system shown in Fig. 2. After the laser beam is expanded to 22 mm diameter with a conventional Galilean ZnSe telescope, it is passed through a "refraxicon" and formed into a 75 mm diameter cylinder with 11 mm diameter walls. This cylinder is turned vertical with a flat mirror at 45° to the beam, and brought to a near diffraction limited focus by a parabolic mirror. All the optics are gold coated diamond turned OFHC copper. The refraxicon is an interesting element, in that the inner and outer cones must be centered to better than a wave at 10.6 μm for good performance. Since it is not possible to manufacture this element as a single piece, a two piece design with mating surfaces was used to bring the centers in line to a fraction of a wave.

We have melted fibers with this optical system and symmetrical heating was observed. The focal spot is less than 100 μm, the resolution of the measurements we have attempted to date. These optics represent a significant advance in the technology of axisymmetric focusing, and may have an impact in a number of materials processing applications.

The fiber drive system must translate the fibers at an accurately controlled rate and maintain the transverse position of the fibers by supporting them close (~ 1 cm) to the melt zone. To these ends we have designed a belt drive system which slides the fiber through a V-block fixed close to the melt zone. The belt is driven by encoded D.C. motors phaselocked to a stable oscillator. We have built a working version of this system, capable of withstanding the heat near the molten zone, and are currently fine tuning it with various combinations of belt and v-groove materials to optimize stability.

The focusing optics and fiber drives all fit inside an 8" x 14" enclosure fitted with O-ring seals to allow the introduction of an inert gas or oxygen environment for the growth, and isolate the melt zone from the influence of changes in ambient conditions. The fiber drives can be adjusted to the center of the fixed focusing system by means of the motorized x-y stages to which they are attached.

We have tested the system on 500 μm $LiNbO_3$ rods and 250 μm sapphire rods. Stable melts and a symmetrical tight focus were achieved in both with several watts of laser power.

To grow well controlled fibers, it will be necessary to incorporate feedback to the motor speeds and laser power based on an error signal derived from in situ measurements of the fiber diameter. A device suitable for these measurements must have a diameter resolution of better than 0.1 μm, a working distance consistent with the CO_2 focusing system (~ 100 μm), a measurement rate faster than the thermal time constant of the growth zone (~ 1 kHz), and axial resolution of 10 μm or better. No commercially available system could meet these requirements, so we designed and constructed a system. The measurement approach is based on fringes created by illuminating the fiber transversely with a He-Ne laser beam. The fringes result from interference between a ray refracted through the fiber and the ray reflected off the surface of the fiber at the same angle. The spacing of these fringes is proportional to the diameter of the fiber. Traditional systems based on this effect[3] have counted the number of fringes present in a given angular range in the far field. The working distance constraints of our apparatus precluded convenient adaptation of this method, so we developed single processing electronics suitable for precisely locating the center of the image on a reticon array of one particular fringe, and tracking that fringe as its position changes due to variations in the fiber diameter.

This technique has several advantages. The optical design is greatly simplified, as only a few fringes need be imaged on the diode array, rather than the several hundred necessary in a counting system. Counting fractional fringes rather than whole fringes increases the resolution available.

Our present system has a fractional resolution of 0.05% for a 100 μm fiber, at a measurement rate of 1 kHz, limited only by the diode array scan time. Simple changes in the imaging optics and a different diode array could up the resolution several fold, if that becomes desirable in the future. The axial resolution of the system is ~ 5 μm, given by the line focus of a f/4 cylindrical doublet. The working distance is 100 mm, which is determined by the focal length of the doublet. The fiber can move in a window of ~ 5 mm x 5 mm without causing error in the measurement. This device is a significant improvement over presently available technology, and may have commercial applications.

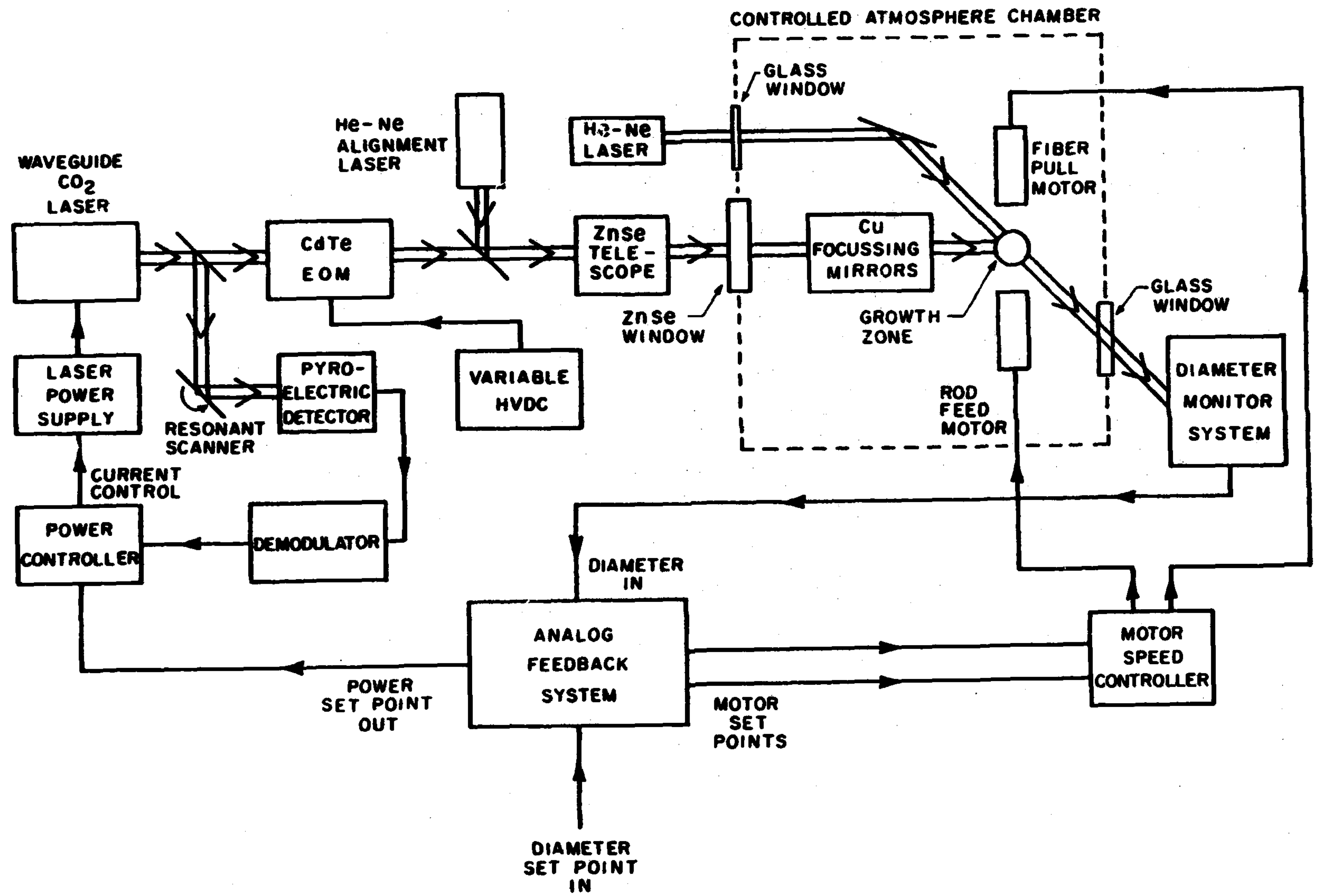
In addition to its utility in the feedback system, the diameter measurement device will have other applications in our program. The Fourier transform of the diameter variations yields their power spectral density, useful both as a diagnostic for uncovering problems with the growth process and as an input in calculations of radiation loss and mode coupling studies.

While our emphasis this year has been on the growth apparatus, we have also refurbished an intracavity doubled YAG laser, making available TEM_{00} beams at 1.83, 1.32, 1.06, 0.91, 0.66 and 0.53 μm for mode propagation and nonlinear studies on fibers, when they become available.

We have also continued our theoretical studies of the effect of random diameter variations on mode coupling and radiation loss in fibers.

CONCLUSION

The development of a second generation growth apparatus and an accurate high speed fiber diameter measurement system will allow systematic investigation of the parameters that control the growth of high quality crystal fibers. Once such fibers are obtained, a broad range of nonlinear device applications become feasible. We feel our work of the past year puts us in a good position to approach these goals.


CONTROLLED ATMOSPHERE CHAMBER
GLASS WINDOW
He-Ne ALIGNMENT LASER
He-Ne LASER
WAVEGUIDE CO_2 LASER
CdTe EOM
ZnSe TELE-SCOPE
Cu FOCUSSING MIRRORS
FIBER PULL MOTOR
GLASS WINDOW
ZnSe WINDOW
GROWTH ZONE
DIAMETER MONITOR SYSTEM
LASER POWER SUPPLY
RESONANT SCANNER
PYRO-ELECTRIC DETECTOR
VARIABLE HVDC
ROD FEED MOTOR
CURRENT CONTROL
POWER CONTROLLER
DEMODULATOR
DIAMETER IN
ANALOG FEEDBACK SYSTEM
MOTOR SPEED CONTROLLER
POWER SET POINT OUT
MOTOR SET POINTS
DIAMETER SET POINT IN
FIGURE 1

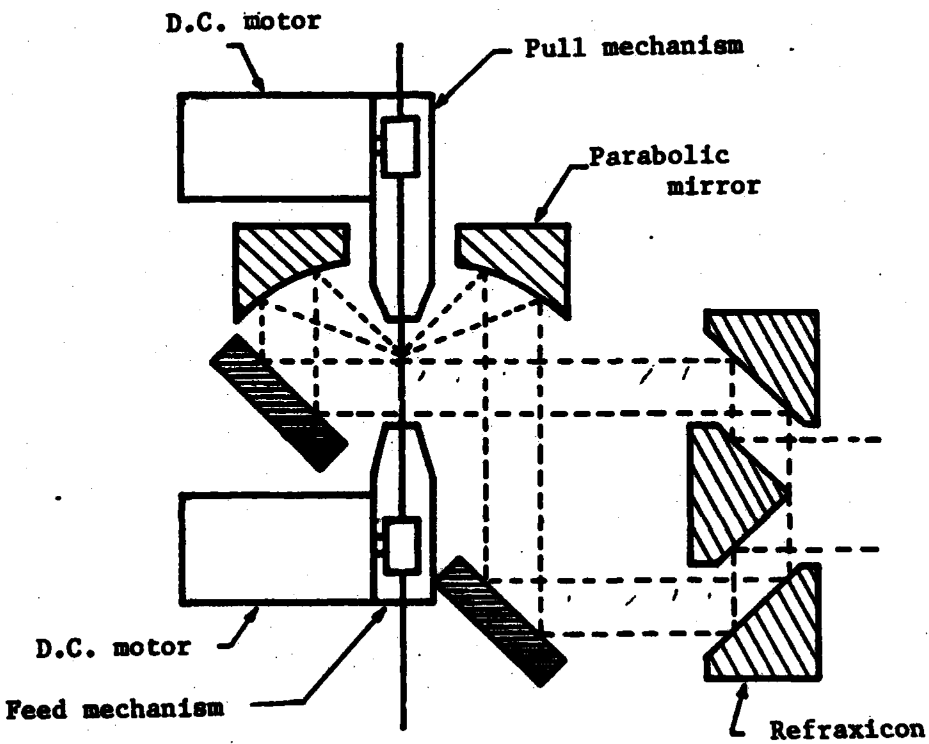

D.C. motor
Pull mechanism
Parabolic mirror
D.C. motor
Feed mechanism
Refraxicon

FIGURE 2

PUBLICATIONS

M. Fejer, R.L. Byer, R. Feigelson, W. Kway, "Growth and Characterization of Single Crystal Refractory Oxide Fibers," in Advances in Infrared Fibers II SPIE Proceedings, Vol. 320, January 26-28, 1982, Los Angeles.

FOOTNOTES

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Unit 81-4

ACOUSTIC SURFACE WAVE SCANNING OF OPTICAL IMAGES

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(J. B. Green)

A. Introduction

At the present time our work focuses on developing acoustic surface wave devices utilizing the interaction between surface acoustic waves and charge carriers in a semiconductor. Most of our device designs involve the use of piezoelectric zinc oxide which is *rf* sputtered onto a silicon substrate. Due to the piezoelectric nature of the zinc oxide, electric fields are generated by the acoustic surface waves propagating along the device. These electric fields penetrate into the silicon substrate and interact with the charge carriers near the silicon surface.

Our work now centers around two types of devices:

(1) A programmable active delay line in which signals can be read into the device by means of a charge transfer device (CTD) integrated into the silicon substrate. After programming the device in this way, we could then use the device in a wide variety of signal processing applications including, but in no way restricted to, adaptive and inverse filtering. This first working device is an excellent example of the uses to which sophisticated LSI technology can be put in sophisticated applications involving real-time analog and digital signal processing.

(2) An acoustic surface wave waveguided correlator.

B. Progress and Accomplishments

A basic building block for surface wave correlators and programmable delay lines is a narrow, waveguided acoustic surface wave device. Narrow beamwidth devices possess an inherent advantage over wider beamwidth devices since the acoustic power density in the propagation path is proportionally higher, resulting in more efficient device operation. In order to generate a narrow acoustic beamwidth over a sufficiently large bandwidth, it is desirable to launch the acoustic waves from interdigital transducers with a relatively wide radiating aperture. This necessitates forming the transducer fingers into concentric circular arcs so that the acoustic beam will focus down to a narrow width. A waveguided convolver fabricated with such focused interdigital transducers must have the waveguide entrances located at the focal plane of the focused transducers. We have recently demonstrated this concept with a $LiNbO_3$ elastic convolver.

The basic geometry of the focused transducer elastic convolver is shown in Fig. 1. The focused interdigital transducers and top-plate/waveguiding electrode are defined as a thin film metallization on the piezoelectric substrate. Electrical signals input into each of the focused transducers are converted into surface acoustic waves which counterpropagate each toward an end of a SAW waveguide. Due to the spatially-imposed phase variation placed on the acoustic wave generated by each focused interdigital transducer, the SAW energy gets focused down into narrow beams at the entrances of the acoustic waveguide. The surface waves then get "captured" by the waveguide and thus remain as tightly collimated beams (≈2 wavelengths wide) which

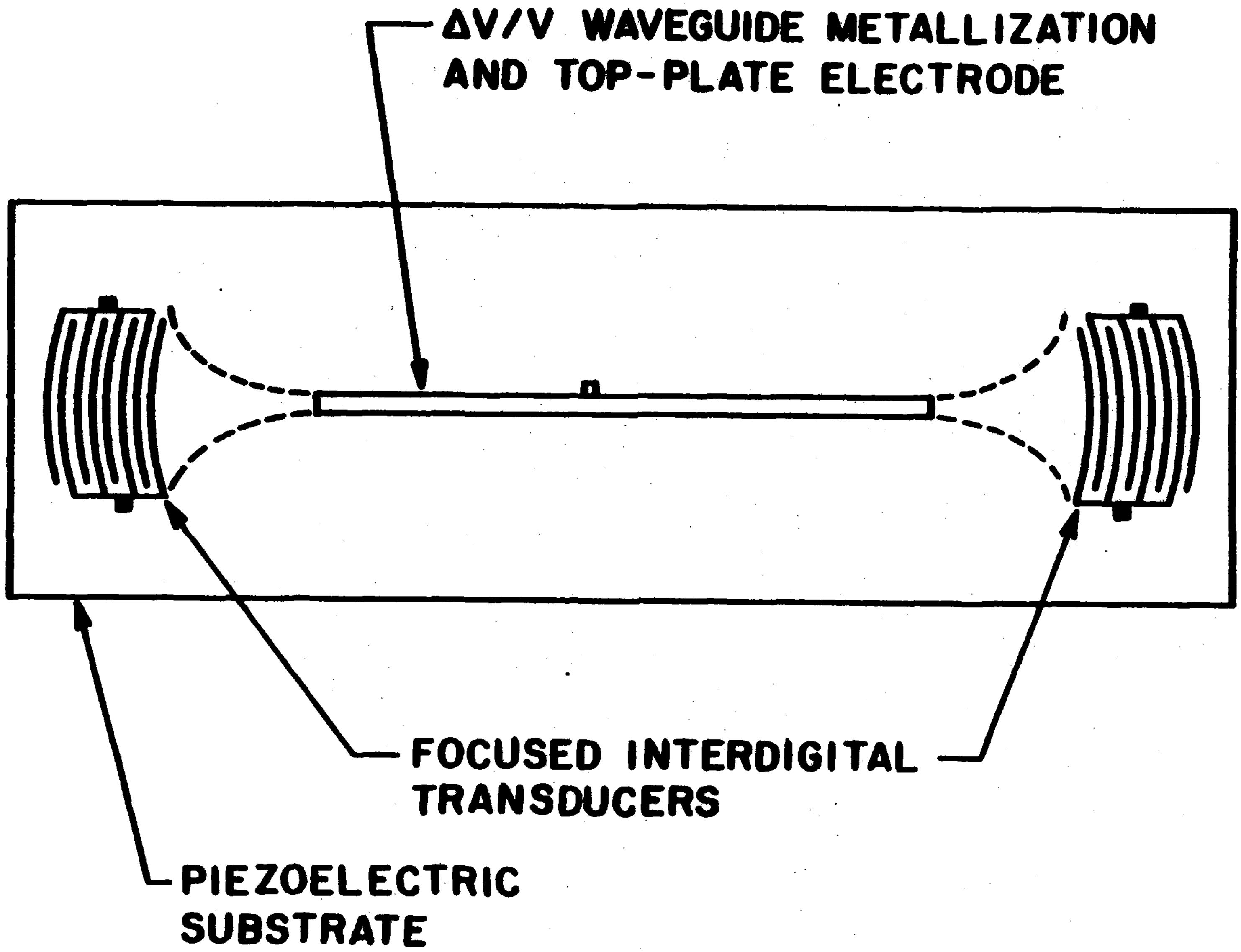


Fig. 1. Schematic of focused transducer/waveguided convolver.

counterpropagate along the length of the device. Since the power density of the compressed, interacting waves remains high in the waveguided structure, the convolver is correspondingly more efficient.

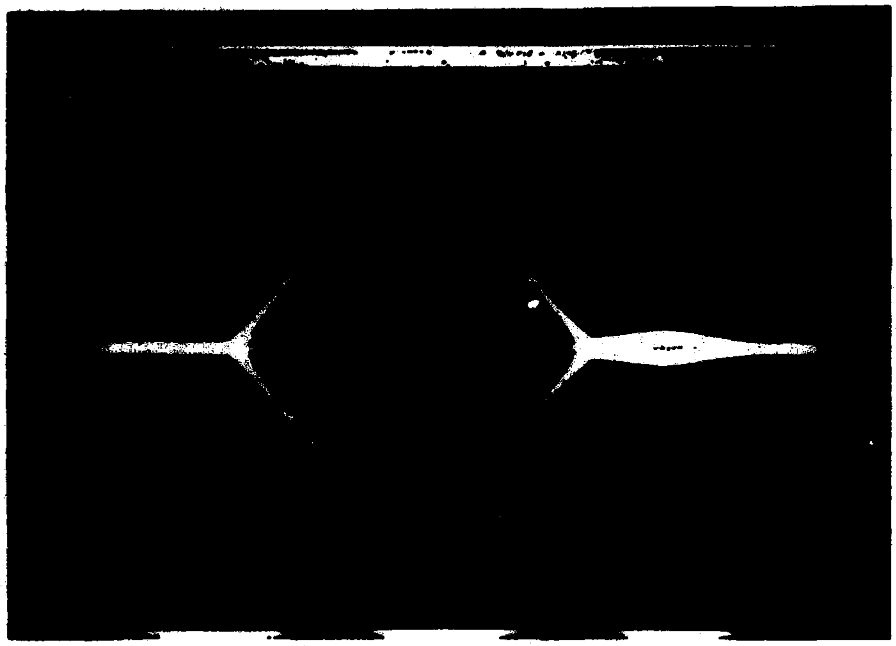
The advantages of using the focused interdigital transducer (FIT) for beamwidth compression are:

1. The FIT has a large active radiation area that is capable of generating a narrow acoustic beam. Thus, its input impedance is much lower than that of a correspondingly narrow interdigital transducer.
2. The FIT is able to perform greater beamwidth compression in a smaller space than the previously used beamwidth compressors. This results in smaller, more efficient devices.
3. The FIT does not require the difficult photolithography necessary for the fabrication of the multi-strip couplers in high-frequency devices.
4. The FIT can accomplish beamwidth compression independent of the electromechanical coupling coefficient ($\Delta v/v$) of the piezoelectric substrate material. This is in contrast to the multistrip coupler or parabolic horn compressor which rely on large values of $\Delta v/v$ to obtain efficient beamwidth compression. Therefore, the focused interdigital transducer is more appropriately suited to low $\Delta v/v$ systems (for example, GaAs devices) than are the other competing methods.
5. The FIT accomplishes beamwidth compression without the dispersion inherent in the horn compressors.

6. The FIT is only one element that accomplishes two tasks: generation of the acoustic beam and compression of the acoustic beam. This results in a device that is easier to fabricate.

The $LiNbO_3$ elastic convolver which we have fabricated using this focused transducer concept for beamwidth compression has provided very encouraging results. Operating at a center frequency of 160 MHz, the device showed a terminal convolution efficiency $F_T = -70$ dBm with an insertion loss of -16 dB. The convolution output of two rectangularly modulated input signals is shown in Fig. 2.

We have also developed a theory for use in the design of such focused transducer/waveguided convolvers. This theory takes into account the efficiency with which the focused transducer is able to excite the fundamental waveguided mode to predict ultimate convolver efficiency. Results from this theory are shown in Fig. 3 where the convolver figure of merit Q is plotted as a function of the acoustic waveguide width a. Higher values of Q represent increased convolver efficiency. The family of curves are drawn for different focused interdigital transducer designs. R represents the radius of curvature of the focused transducers and w indicates the transducer finger lengths. We see that maximum convolution efficiency is obtained for waveguides a little less than one acoustic wavelength wide, independent of the focused transducer's design.



Convolution Output from FIT/Waveguide Convolver

1 μsec/div

Fig. 2.

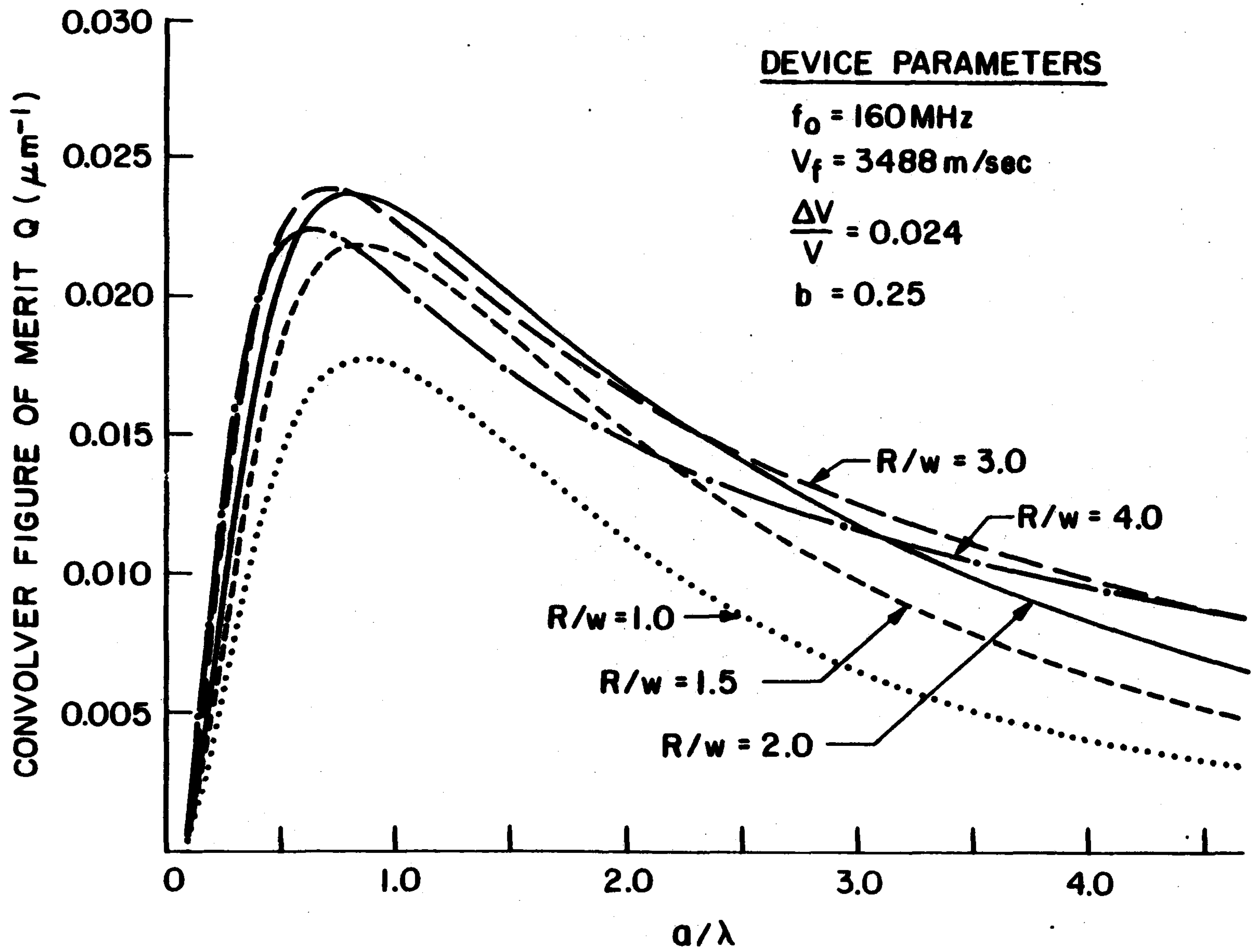


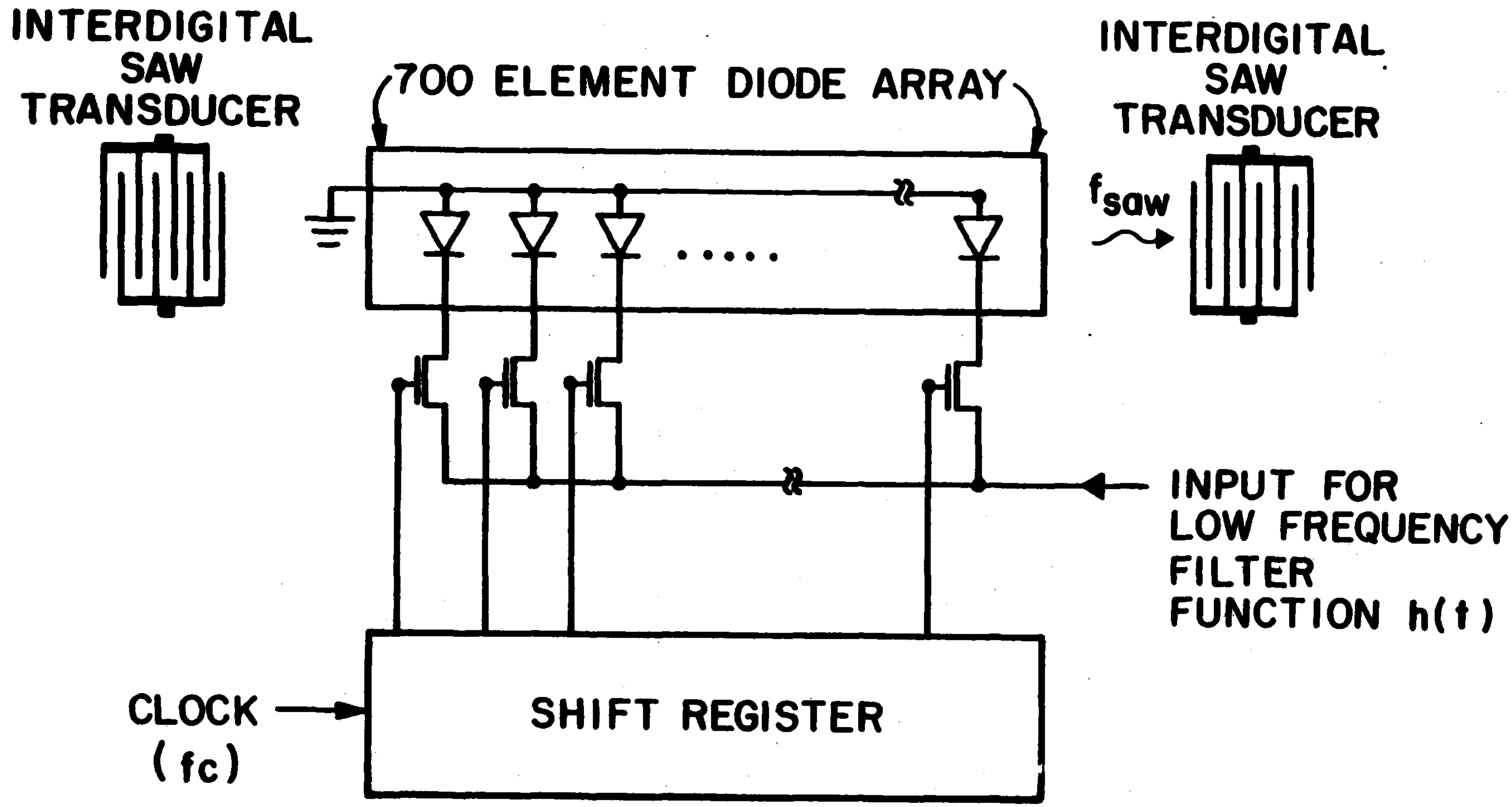
Fig. 3. Convolver efficiency vs. waveguide width.

The SAW/FET: A New Programmable SAW Transversal Filter

We have demonstrated for the first time a totally monolithic surface acoustic wave transversal filter which utilizes an integrated multiplexed FET array to program the desired filter function. The device (called the SAW/FET) is based on ZnO on Si SAW technology with the FET array being fabricated using a standard NMOS processing schedule.

The basic SAW/FET design is depicted in Fig. 4. The top portion of this schematic shows interdigital transducers and diodes arranged in the same configuration as in the ZnO/Si storage correlator shown in Fig. 5. A 2 μm thick film of ZnO is sputter-deposited onto an oxidized p-type Si (8Ω-cm) wafer in which n^+ implants form an array of diodes underneath the acoustic beam path. A thin film Au metallization on top of the zinc oxide defines the interdigital transducers and top-plate electrode. Additionally, each diode in the SAW/FET is connected to an individual FET, with all the drains of the FETs connected to a common bus. The gate of each FET is in turn controlled by a tapped output of a single-bit shift register.

The multiplexed FET array controls 700 taps for the sampling and storage of an acoustic waveform. The surface acoustic wave interdigital transducers operate at a center frequency f_0 = 100 MHz, generating an acoustic wave (first Rayleigh mode) with a wavelength of 40 μm. Since each tap is 5 μm wide, separated by a 5 μm space, we see that we have four taps per rf cycle, a number more than sufficient to satisfy the Nyquist criterion for the accurate sampling of an analog waveform. The 700 FET array provides a far greater tap density than that of any other SAW-based slowly programmable transversal filter known to date.



$f_{saw} >> fc$

SCHEMATIC OF SAW/FET DEVICE

Fig. 4.

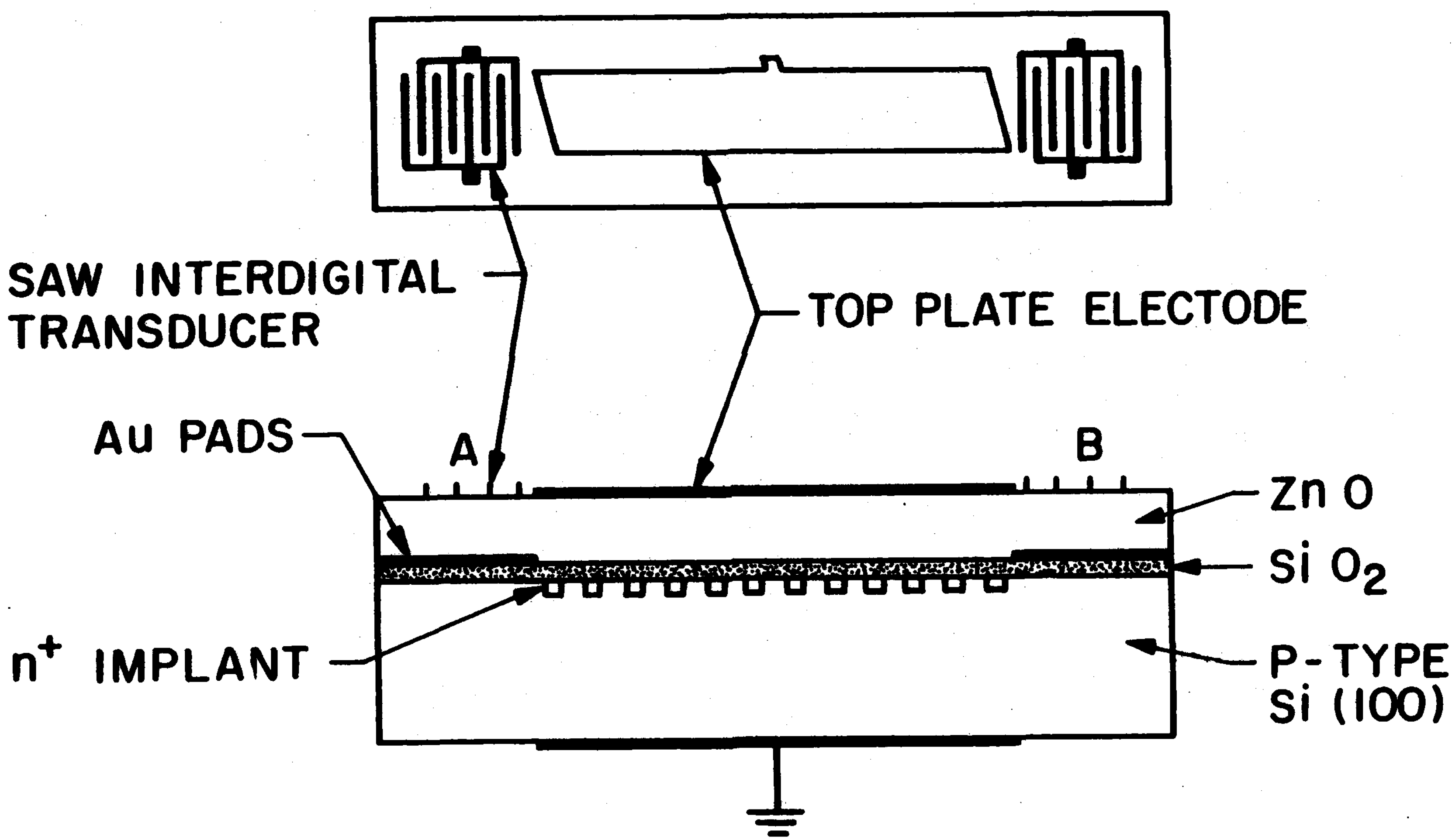


Fig. 5. Schematic of ZnO/Si Storage Correlator.

The SAW/FET construction has necessitated close cooperation between the Ginzton Laboratory and the Integrated Circuit Laboratory at Stanford. The 700-tap multiplexed FET array was designed by the IC Laboratory and is the largest IC built in that lab. The ZnO films required for this acoustic device, as well as the acoustic transducers needed, were made in the Ginzton Laboratory.

A low-speed waveform is inserted into the device by applying an analog signal $h(t)$ to the common drain line of the FET array while simultaneously clocking the single-bit tapped shift register. It can be seen that when the multiplexed FETs are switched on by the tapped shift register, a different sample of the analog waveform is stored in successive diodes in the array. The waveform samples are stored as charge on the reverse-biased diodes so that this array of reverse-biased diodes has a capacitance variation $C(z)$ along the length of the device that is representative of the original analog input signal $h(t)$. The z direction is defined to be along the device length, colinear with the direction of propagation of the surface acoustic waves. Since the diode array capacitance $C(z)$ is in series with the capacitance of the ZnO layer, applying a signal $g(t)$ to the plate electrode results in a spatially-varying voltage across the ZnO film. This voltage has the same fundamental spatial harmonic component as the capacitance variation $C(z)$. Since the ZnO film is piezoelectric, a capacitance variation $C(z)$ which has a $\cos(kz)$ modulation, and an input waveform $g(t)$ which has a $\cos(\omega t)$ modulation, will give rise to an acoustic surface wave signal received by the interdigital transducer that is proportional to the correlation of $g(t)$ and $h(t)$. This is known as plate-to-acoustic readout. The output will be large only when $k = \omega/v_a$ where v_a is the surface acoustic wave propagation velocity.

Figure 6 shows the high-speed correlation output of an rf modulated rectangle (f_o = 96 MHz) 1 μsec in length with a low-frequency modulated rectangular charge pattern stored in one-half of the diode array via the multiplexed FET array. The low-frequency modulation at 103 kHz was chosen with respect to the shift register clock frequency so that the resulting stored charge pattern had the correct $\cos(kz)$ variation with the wave vector k satisfying the relation $k = \omega/v_a$.

Figure 7 shows the correlation output of a 96 MHz modulated 3-bit Barker code (++-) with a low-frequency modulated 3-bit Barker code previously stored in the device. The peak-to-sidelobe ratio is seen to equal 3:1 , the expected value for the autocorrelation of a 3-bit Barker code.

The peak signals are observed to be 23 dB above the acoustically-generated spurious signal. These spurious signals are due to acoustic feedthrough caused by nonuniformities in the ZnO layer. There also exist strong capacitive feedthrough signals picked up by the interdigital transducers which are located close to the plate electrode. We believe that these nonuniformities and pick-up problems can be minimized by a slight modification of the FET array processing schedule, and by placing ground metallizations between the interdigital transducers and the top-plate electrode. This will be done in subsequent devices, hopefully resulting in a much larger dynamic range.

It must be noted that this present device has a processing bandwidth limited only by the interdigital transducers. Since the high tap density

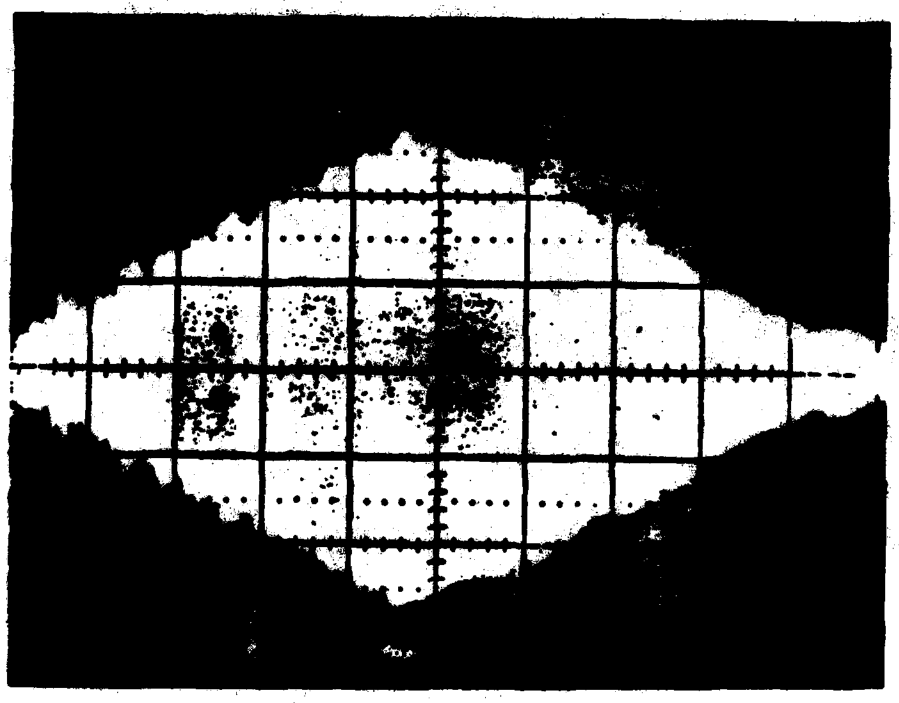


Fig. 6. SAW/FET Correlation output of two rectangles. Horizontal scale: 0.1 microsecond/division.

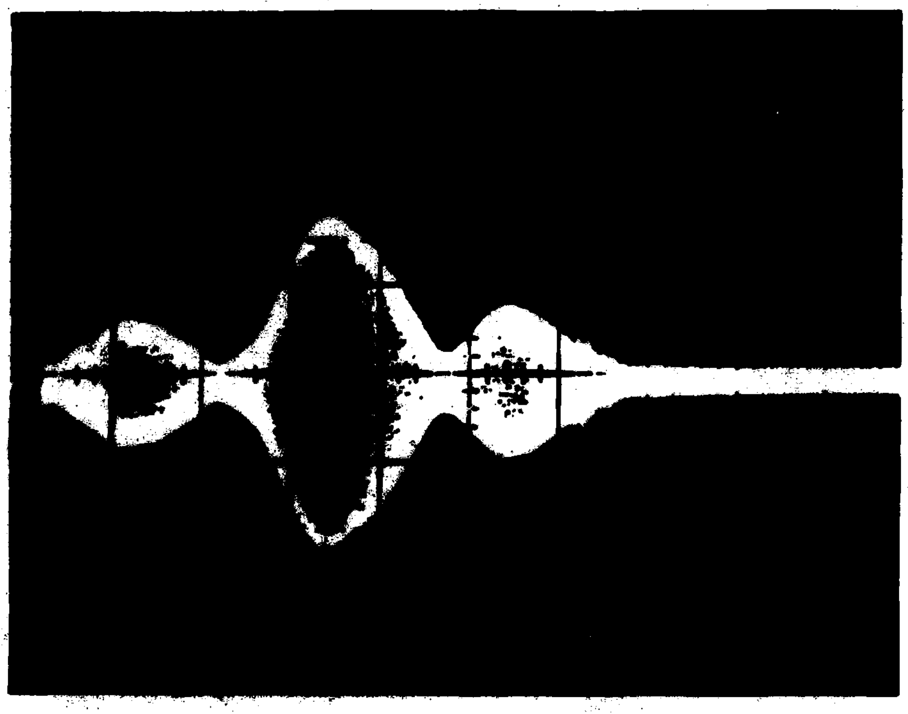


Fig. 7. SAW/FET correlation output of two 3-bit Barker codes. Horizontal scale: 0.1 microsecond/division.

allows the processing of signals with bandwidths in excess of 200 MHz, improved device performance can be obtained by utilizing higher frequency transducers operating in the Sezawa mode to achieve greater IDT bandwidths.

In conclusion, we have demonstrated a new, flexible, monolithic transversal filter. The SAW/FET takes full advantage of the ZnO on Si technology and demonstrates the manner in which integrated circuit technology may be combined with surface acoustic wave technology to achieve a monolithic device capable of sophisticated high-speed signal processing. The advantages of such a monolithic design include mechanical stability and ease of fabrication.

We believe that these concepts are merely the first of a wide range of devices which could be constructed with entirely new configurations and systems architecture if the necessary LSI and VLSI silicon technology were available. We have described here, for instance, a device controlled only by a shift register output; a still more flexible and valuable signal processing device could be made if the control were directly made from a random access memory (RAM) output rather than the shift register. Other possible future devices might use amplifiers in the acoustic analog system rather than passive diodes. Thus, with a sophisticated VLSI technology available, new devices developed to carry out analog or digital signal processing in real time at very high frequencies.

PUBLICATIONS AND PAPERS

1. J. B. Green, G. S. Kino, J. T. Walker, and J. D. Schott, "Novel Programmable High-Speed Analog Transversal Filter," to be published in Electron Device Letters (October 1982).
2. J. B. Green, G. S. Kino, J. T. Walker and J. D. Schott, "The SAW/FET: A New Programmable SAW Transversal Filter," to be presented at the 1982 Ultrasonics Symposium (October 1982).
3. J. B. Green, and G. S. Kino, "SAW Convolvers Using Focused Interdigital Transducers," submitted for publication to IEEE Transactions on Sonics and Ultrasonics.

Unit 81-5

PICOSECOND RAMAN STUDIES OF ELECTRONIC SOLIDS

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(415)497-0222

(C.E. Barker)

A. Introduction

The scientific objective of this project is the study of fast electronic and lattice processes in semiconductors (with a focus on silicon) using a novel picosecond-time-resolved Raman spectrometer.

This project takes advantage of the availability of a special time-resolved resonance Raman apparatus built by our group a few years ago primarily for biological investigations. This spectrometer uses a high rep-rate, flash-pumped, mode-locked and pulse-selected neodymium YAG laser which can generate both 1.06 μm and 532 nm pulses having durations less than 30 psec, at a repetition rate of 30 pulses per second. We intend to use pulses from this laser, at either wavelength, to photoexcite a semiconductor sample (through optical heating and carrier generation) and also to measure the Raman spectrum of the sample through a high-quality Raman spectrometer.

Conventional picosecond time-resolved measurements of reflectivity or transmission on semiconductors measure primarily the electronic properties of the sample. A time-resolved Raman apparatus such as this, by contrast, will be able to observe primarily the lattice properties, particularly the lattice temperature of the semiconductor sample, on a picosecond time basis.

B. Progress and Accomplishments

Conversion of the time-resolved Raman system so that it can be used both for the biological observations for which it was originally designed (under other sponsorship) and for semiconductor measurements, is nearly complete. We have had some experimental difficulties in bringing the optical multi-channel analyzer (OMA) into satisfactory operation on the Raman spectrometer, so as to permit Raman spectra over a wide wavelength range to be collected simultaneously.

Preliminary Raman spectra from silicon samples using relatively low energy 532 nm pulses have now been collected on this instrument, and observed to be substantially different from silicon spectra collected on the same instrument using a cw argon laser at essentially the same wavelength (514 nm). The pulsed Raman spectra have substantially wider linewidths, for reasons which are not at this point understood.

The controversy of recent years over the relative roles of electronic plasma and lattice heating effects in the laser annealing of silicon seems to be tending in favor of a relatively straightforward lattice heating model. It is still entirely unknown, however, exactly how fast the initial electronic excitation produced by a fast laser pulse converts over into thermalized excitation of the semiconductor lattice. Time-resolved Raman measurements with picosecond time resolution such as those we are planning have the potential of answering this question.

Once our apparatus is working, therefore, our program will be to explore the situation in which a silicon sample is simultaneously heated by a picosecond laser pulse at 1.06 μm and the lattice temperature measured by a slightly delayed picosecond pulse at 532 nm. The lattice temperature will be monitored by observing both the broadening of the standard Stokes-Raman line, and also the amplitude ratio of the Stokes to anti-Stokes-Raman lines.

In order to make such measurements accurately, it is necessary to have an accurate calibration of the variation of both of these quantities with a sample temperature in our particular apparatus. In order to accomplish this calibration a small oven for heating silicon samples to accurately known temperatures will be constructed and installed in our apparatus. Carrying out calibration measurements, followed by an extensive series of time-resolved pulse heating measurements on silicon samples, and the interpretation of these measurements, are expected to be our main activities during the coming year.

SECTION IV

PUBLICATIONS CITING JSEP SPONSORSHIP

G.L. No.	Title	Contract/Grant
3262	M.R. Beasley and C.J. Kircher, "Josephson Junction Electronics: Materials Issues and Fabrication Techniques," Preprint (May 1981). Also Published in Superconductor Materials Science, eds. Simon Foner and Brian B. Schwartz (Plenum Publishing Corporation, 1981).	N00014-75-C-0632
3279	R.B. van Dover, A. de Lozanne, and M.R. Beasley, "S-N-S Microbridges: Fabrication, Electrical Behavior and Modeling," Preprint (June 1981). Also: Published in Journal of Applied Physics, Vol. 52, No. 12, 7327-7343 (December 1981).	N00014-75-C-0632
3291	B.A. Auld, S. Ayter, M. Tan, and D. Hauden, "Filter Detection of Phase-Modulated Laser Probe Signals," Preprint (July 1981).	N00014-79-C-0222 and N00014-75-C-0632
3309	B.A. Auld and M.M. Fejer, "Elastic Non-linearity and Domain Wall Motion in Ferroelastic Crystals," Preprint (August 1981).	N00014-75-C-0632
3315	Staff, "Annual Progress Report and Report of Significant Accomplishments," for the period 1 April 1980 through 31 March 1981.	N00014-75-C-0632
3338	R. Trebino, J.P. Roller, and A.E. Siegman, "A Comparison of the Casegrain and Other Beam Expanders in High-Power Pulsed Dye Lasers," Preprint (October 1981). To appear in the August 1982 issue of IEEE Journal of Quantum Electronics.	AFOSR-80-0145 and N00014-75-C-0632

3367	R.A. Bergh, M.J.F. Digonnet, H.C. Lefevre, S.A. Newton, and H.J. Shaw, "Single Mode Fiber Optic Components," Preprint (December 1981).	N00014-75-C-0632 and Atlantic Richfield Co.
3402	J.B. Green and G.S. Kino, "SAW Convolvers Using Focused Interdigital Transducers," Preprint (March 1982). Submitted to IEEE Transactions on Sonics and Ultrasonics.	N00014-75-C-0632

SECTION V

REPORTS AND PUBLICATIONS

EDWARD L. GINZTON LABORATORY FACULTY AND STAFF

G.L. No.	Title	Contract/Grant
3244	B.T. Khuri-Yakub, J.G. Smits, and T. Barbee, "Reactive Magnetron Sputtering of ZnO, Preprint (April 1981). Also: Published in Journal of Applied Physics, Vol. 52, No. 7, 4772-4774 (July 1981).	N00014-78-C-0129
3245	J. Heiserman, "Cryogenic Acoustic Microscopy," Reprint from Scanned Image Microscopy (Academic Press, 1980), pp. 71-95.	N00014-77-C-0412
3246	Staff, "Nondestructive Evaluation of Structural Ceramics," Six-Month Progress Report for the period October 1, 1980 to February 28, 1981 (March 1981).	AMES SC-81-009
3247	Se-Jung Oh and S. Doniach, "Fluorescent Electron Emission--A Prediction for Resonant Photoemission Spectra," Reprint from Physics Letters, Vol. 81A, No 8, 483-487 (18 February 1981).	NSF DMR79-13102
3248	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 53rd Report for the period 1 February to 31 March 1981 (April 1981).	EPRI RP609-1
3249	Staff, "Acoustic Microscopy for Non-destructive Evaluation of Materials," R & D Status Report for the period 1 February to 30 April 1981 (April 1981).	F49620-78-C-0098
3250	A.E. Siegman, "Passive Mode Locking Using an Antiresonant Ring Laser Cavity," Preprint (April 1981). Also: Published in Optics Letters, Vo. 6, No. 7, 334-335 (July 1981).	AFOSR-80-0145

G.L. No.	Title	Contract/Grant
3251	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 27th Monthly Report for the period 1 March to 1 April 1981 (April 1981).	EPRI RP 1395-3
3252	M.D. Wright, D.M. O'Brien, J.F. Young, and S.E. Harris, "Laser Induced Charge Transfer Collisions of Calcium Ions with Strontium Atoms," Preprint (April 1981). Also: Published in Physical Review A, Vol. 24, No. 4, 1750-1755 (October 1981).	F49620-80-C-0023
3253	N.W. Carlson, A.J. Taylor, K.M. Jones, A.L. Schawlow, "Two-Step Polarization Labeling Spectroscopy of Excited States of Na_2," Preprint (April 1981). Also: Published in Physical Review A, Vol. 24, No. 2, 822-834 (August 1981).	NSF PHY80-10689
3254	G.A. Zdasiuk, "Atomic Pair Processes and Laser Application," Internal Memorandum (April 1981).	F49620-80-C-0023
3255	R.L. Byer, Y.K. Park, R.S. Feigelson, and E.L. Kway, "Efficient Second Harmonic Generation of Nd:YAG Laser Radiation using Warm Phasematching $LiNbO_3$," Preprint (April 1981). Also: Published in Applied Physics Letters, Vol. 39, No. 1, 17-19 (1 July 1981).	LLL 3488009
3256	Staff, "Measurement of Surface Defects in Ceramics," End of Year Report - 1980 (April 1981).	N00014-78-C-0283
3257	H. Park, M. Chodorow, and R. Kompfner, "High Resolution Optical Ranging System," Preprint (June 1981). Also: Published in Applied Optics, Vol. 20, No. 14, 2389-2394 (15 July 1981).	-----

G.L. No.	Title	Contract/Grant
3258	Staff, "Application of CARS Spectroscopy to Turbulence Measurements," Final Report (April 1981).	NASA/Ames NSG 2289
3259	R.B. King, G. Herrmann, and G.S. Kino, "Use of Stress Measurements with Ultrasonics for Nondestructive Evaluation of the J Integral," Preprint (April 1981). Also: Published in Engineering Fracture Mechanics, Vol. 15, No. 1-2, 77-86 (1981).	F49620-79-C-0217 and EPRI RP609-1
3260	J.E. Bowers, "Broadband Monolithic Sezawa Wave Storage Correlators and Convolvers," Internal Memorandum (May 1981).	N00014-76-C-0129
3261	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 28th Monthly Report for the period 1 April to 1 May 1981 (May 1981).	EPRI RP1395-3
3262	M.R. Beasley and C.J. Kircher, "Josephson Junction Electronics: Materials Issues and Fabrication Techniques," Preprint (May 1981). Also: Published in Superconductor Materials Science, eds. Simon Foner and Brian B. Schwartz (Plenum Publishing Corporation, 1981).	N00014-75-C-0632
3263	W.A. Harrison, "New Tight-Binding Parameters for Covalent Solids Obtained using Louie Peripheral States," Preprint (May 1981). Also: Published in Physical Review B, Vol. 24, No. 10, 5835-5843 (15 November 1981).	NSF DMR80-22365
3264	Staff, "Film Synthesis and New Superconductors," Interim Technical Report for the period 1 October 1980 to 31 March 1981 (May 1981).	F49620-78-C-0009

G.L. No.	Title	Contract/Grant
3265	J. Kwo, T.P. Orlando, and M.R. Beasley "The Microscopic Superconducting Parameters of Nb_3Al: How Important is the Band Density of States?", Preprint (June 1981). Also: Published in Physical Review B, Vol. 24, No. 5, 2506-2514 (1 September 1981).	DOE DE-AT03-76ER71043 and F49620-78-C-0009
3266	Staff, "Laser Physics and Laser Techniques," Interim Scientific Report for the period 1 January 1980 to 31 January 1981.	AFOSR-80-0145
3267	T.P. Orlando and M.R. Beasley, "Pauli Limiting and Possibility of Spin Fluctuations in the A15 Superconductors," Preprint (June 1981). Also: Published in Physical Review Letters, Vol. 46, No. 24, 1598-1601 (15 June 1981).	DOE DE-AT03-76ER71043
3268	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 29th Monthly Report for the period 1 May to 1 June 1981 (June 1981).	EPRI RP1395-3
3269	G.A. Pavlath and H.J. Shaw, "Birefringence and Polarization Effects in Fiber Gyroscopes," Preprint (June 1981). Also: Published in Applied Optics, Vol. 21, No. 10, 1752-1757 (15 May 1982).	F49620-80-C-0040
3270	J.E. Bowers and G.S. Kino, "Adaptive Noise Cancellation with a SAW Storage Correlator," Preprint (June 1981). Also: Published in Electronics Letters, Vol. 17, No. 13, 460-461 (25 June 1981).	N00014-76-C-0129

G.L. No.	Title	Contract/Grant
3271	W.L. Carter, S.J. Poon, G.W. Hull, Jr., and T.H. Geballe, "Enhanced Critical Field Curves of Metastable Superconductors," Preprint (June 1981). Also: Published in Solid State Communications, Vol. 39, 41-45 (1981).	F49620-78-C-0009
3272	R. King, G. Herrmann, and G. Kino, "Acoustic Nondestructive Evaluation of Energy Release Rates in Plane Cracked Solids," Preprint (June 1981).	EPRI RP609-1 and NSF-MRL (CMR)
3273	J.J.W. Tien, B.T. Khuri-Yakub, G.S. Kino, A.G. Evans, and D. Marshall, "Surface Acoustic Wave Measurements of Surface Cracks in Ceramics," Preprint (June 1981).	N00014-78-C-0283
3274	B.T. Khuri-Yakub, C.H. Chou, K. Liang, and G.S. Kino, "NDE for Bulk Defects in Ceramics," Preprint (June 1981).	F49620-79-C-0217
3275	S.D. Bennett, D. Husson, and G.S. Kino, "Focused Acoustic Beams for Accurate Phase Measurements," Preprint (June 1981). To be published in Acoustical Imaging, Vol. 11, pp. 583-596.	EPRI RP609-1 and F49620-79-C-0217
3276	N. Grayeli, F. Stanke, G.S. Kino, and J.C. Shyne, "Effect of Grain Size and Preferred Crystal Texture on Acoustic Properties of 304 Stainless Steel," Preprint (June 1981).	F49620-79-C-0217
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G.L. No.	Title	Contract/Grant
3279	R.B. van Dover, A. de Lozanne, and M.R. Beasley, "S-N-S Microbridges: Fabrication, Electrical Behavior and Modeling," Preprint (June 1981). Also: Published in Journal of Applied Physics, Vol. 52, No. 12, 7327-7343 (December 1981).	N00014-75-C-0632
3280	W.P. Lowe, T.W. Barbee, Jr., T.H. Geballe, and D.B. McWhan, "X-Ray Scattering from Multilayers of NbCu," Preprint (June 1981). Also: Published in Physical Review B, Vol. 24, No. 9, 5063-5070 (15 November 1981).	F49620-78-C-0009
3281	R.D. Feldman, "Growth of A15 Nb-Si by Epitaxy and Composition Grading," Preprint (June 1981). Also Published in Thin Solid Films, Vol. 87 243-258 (1982).	F49620-78-C-0009
3282	K.E. Kihlstrom and T.H. Geballe, "Tunneling $\alpha^2 F(\omega)$ as a Function of Composition in A15 NbGe," Preprint (June 1981). Also: Published in Physical Review B, Vol. 24, No. 7, 4101-4104 (1 October 1981).	F49620-78-C-0009
3283	K. Liang, B.T. Khuri-Yakub, C.H. Chou, G.S. Kino, K. Peterson, and S. Bennett, "A 50 MHz Synthetic Focus System," Preprint (June 1981).	F49620-79-C-0217 and Ames SC-81-009
3284	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 54th Monthly Report for the period 1 April to 31 May 1981 (June 1981).	EPRI RP609-1
3285	Robert L. Thornton, "Schottky Barrier Elevation by Ion Implantation and Implant Segregation," Preprint (June 1981). Also: Published in Electronics Letters, Vol. 17, No. 14, 485-486 (9 July 1981).	N00014-76-C-0129

G.L. No.	Title	Contract/Grant
3286	A.J. Taylor, K.M. Jones, and A.L. Schawlow, "A Study of Excited ${}^1\Sigma_g^+$ States in Na_2," Preprint (July 1981). Also: Published in Optics Communications, Vol. 39, No. 1,2, 47-50 (15 September 1981).	NSF PHY80-10689
3287	H.-R. Xia, G.-Y. Yan, and A.L. Schawlow, "Two-Photon Line Shapes with Near-Resonant Enhancement," Preprint (June 1981). Also: Published in Optics Communications, Vol. 39, No. 3, 153-158 (1 October 1981).	NSF PHY80-10689
3288	Ph. Dabiewicz and T.W. Hänsch. "Polarization Intermodulated Excitation (POLINEX) Spectroscopy of the CuI 578.2 nm Transition," Preprint (June 1981). Also: Published in Optics Communications, Vol. 38, No. 5,6, 351-356 (1 September 1981).	NSF PHY80-10689
3289	S.E. Harris, R.W. Falcone, M. Gross, R. Normandin, K.D. Pedrotti, J.E. Rothenberg, J.C. Wang, J.R. Willison, and J.F. Young, "Anti-Stokes Scattering as an XUV Radiation Source," Preprint (July 1981).	N00014-78-C-0403, F49620-80-C-0023, NASA NAG 2-44
3290	R.A. Bergh, H.C. Lefevre, and H.J. Shaw, All-Single-Mode Fiber-Optic Gyroscope with Long Term Stability," Preprint (July 1981). Also: Published in Optics Letters, Vol. 6, No. 10, 502-504 (October 1981).	Atlantic Richfield Co.
3291	B.A. Auld, S. Ayter, M. Tan, and D. Hauden, "Filter Detection of Phase-Modulated Laser Probe Signals," Preprint (July 1981). Also: Published in Electronics Letters, Vol. 17, No. 18, 661-662 (3 September 1981).	N00014-79-C-0222 and N00014-75-C-0632

G.L. No.	Title	Contract/Grant
3292	Staff, "Research Studies on Radiative Collisional Processes," Semi-Annual Report for the period 2 January to 30 June 1981 (July 1981).	F49620-80-C-0023
3293	B. Burgoyne, J. Pavkovich, and G.S. Kino "Digital Filtering of Acoustic Images," Preprint (August 1981).	---------
3294	M.R. Beasley, "New Perspectives on the Physics of High-Field Superconductors," Preprint (July 1981). To be published in Advances in Cryogenic Engineering (Materials), Vol. 28, 345-360.	DOE DE-AT03-76ER71043
3295	Staff, "Acoustic Microscopy for Non-destructive Evaluation of Materials," Annual Report for the period 1 July 1980 to 30 June 1981 (July 1981).	F49620-78-C-0098
3296	J.-M. Heritier, J.E. Fouquet, and A.E. Siegman, "Photoacoustic Cell Using Elliptical Focusing," Preprint (September 1981). Also: Published in Applied Optics, Vol. 21, No. 1, 90-93 (January 1982).	AFOSR-80-0145 and NASA NAG 2-44
3297	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 30th Monthly Report for the period 1 June to 1 July 1981 (July 1981).	EPRI RP1395-3
3298	Staff, "Laser Physics and Laser Spectroscopy," Final Technical Report for the period 15 February 1980 to 14 February 1981 (July 1981).	AFOSR-80-0144
3299	Walter A. Harrison, "Electronic Structure and Properties of Nonmetals under Pressure," Preprint (August 1981). Also: Published in Physics of Solids Under Pressure (North-Holland Publishing Co., 1981), pp. 57-65.	NSF DMR80-22365

G.L. No.	Title	Contract/Grant
3300	S. Doniach and C. Sommers, "The Use of Local Density Functional Theory for Spin Polarized Relativistic Band Structure Calculations," Reprint from Valence Fluctuations in Solids, (1981).	--------
3301	M. Chodorow, "Nonlinear Generation of Sound in the Scanning Acoutic Microscope," Final Report for the period 15 July 1977 to 28 February 1981.	NSF ENG77-01119
3302	J.E. Heiserman, "Cryogenic Acoustic Microscopy: The Search for Ultrahigh Resolution Using Cryogenic Liquids," Preprint (August 1981). Presented at the International Conference on LT-16. To be published in Physica.	N00014-77-C-0412
3303	H. Vanherzeele, J.L. Van Eck, and A.E. Siegman, "Mode-Locked Laser Oscillation Using Self-Pumped Phase Conjugate Reflection," Preprint (September 1981). Also: Published in Optics Letters, Vol. 6, No. 10, 467-469 (October 1981).	AFOSR-80-0145
3304	Staff, "Acoustically Scanned Optical Imaging Devices," Semiannual Report No. 12, for the period 1 January to 30 June 1981 (August 1981).	N00014-76-C-0129
3305	H. Vanherzeele, J.L. Van Eck, and A.E. Siegman, "Colliding Pulse Mode-Locking of a Nd:YAG Laser with an Antiresonant Ring Structure," Preprint (September 1981). Also: Published in Applied Optics, Vol. 20, No. 20, 3484-3486 (15 October 1981).	AFOSR-80-0145
3306	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 55th Report for the period 1 June to 31 July 1981 (August 1981).	EPRI RP609-1
3307	A. Arbel and J. Bowers, "Active Matching Circuits for SAW Devices," Preprint (August 1981).	DE-AM03-76SF00326 and N00014-76-C-0129

G.L. No.	Title	Contract/Grant
3308	M.R. Beasley, T.H. Geballe, and H.A. Schwettman, "To Study the RF Properties of Superconducting A15 Compounds," Final Technical Report (July 1981).	N00019-79-C-0618
3309	B.A. Auld and M.M. Fejer, "Elastic Non-linearity and Domain Wall motion in Ferroelastic Crystals," Preprint (August 1981).	N00014-75-C-0632
3310	B.A. Auld and H.A. Kunkel, "Laser Probe Measurements of Material Properties and Elastic Vibration Distributions in Counterpoled Ceramics," Preprint (September 1981). Also: Published in Ferroelectrics, Vol. 38, 971-974 (1981).	N00014-79-C-0222
3311	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 31st Monthly Report for the period 1 July to 1 August 1981 (August 1981).	EPRI RP1395-3
3312	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 32nd Monthly Report for the period 1 August to 1 September 1981 (September 1981).	EPRI RP1395-3
3313	Staff, "Studies on Lasers and Laser Devices," Semiannual Status Report for the period 1 April to 30 September 1981 (September 1981).	NASA NAG 2-44
3314	Staff, "Elastic Domain Wall Waves in Ferroelectric Ceramics and Single Crystals," Annual Progress Report for the period 1 February 1980 to 31 January 1981 (September 1981).	N00014-79-C-0222
3315	Staff, "Annual Progress Report and Report of Significant Accomplishments," for the period 1 April 1980 through 31 March 1981.	N00014-75-C-0632
3316	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," Annual Report (September 1981).	EPRI RP609-1

G.L. No.	Title	Contract/Grant
3317	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," Summary Report for the period 1 October 1980 to 1 October 1981), (October 1981).	EPRI RP1395-3
3318	S.D. Bennett, "Approximate Materials Characterization by Coherent Acoustic Microscopy," Preprint (September 1981).	F49620-79-C-0217
3319	M. Digonnet and H.J. Shaw, "Analysis of a Tunable Single Mode Optical Fiber Coupler," Preprint (September 1981). Also: Published in IEEE Journal of Quantum Electronics, Vol. QE-18, No. 4, 746-754 (April 1982).	Atlantic Richfield Co.
3320	Staff, "Elastic Domain Wall Waves in Ferroelectric Ceramics and Single Crystals," End of Year Letter (October 1981).	N00014-79-C-0222
3321	J. Heiserman, "Thermal Grounding of a Transmission Line in a Dilution Refrigerator," Preprint (September 1981). Also: Published in Cryogenics, 243-244 (May 1982).	N00014-77-C-0412
3322	B.A. Auld and D.K. Winslow, "Microwave Eddy-Current Experiments with Ferromagnetic Resonance Probes," Reprint from Journal of Special Technical Publication, Vol. 733, American Society for Testing and Materials, 332-347 (1981).	-------
3323	R.L. Byer and M. Endemann, "Remote Measurements of Trace Species in the Troposphere," Prepint (September 1981). Also: Published in AIAA Journal, Vol. 20, No. 3, 395-403 (March 1982).	DAAG29-77-G-0181

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3324	D.A. Brown and S. Doniach, "Vortex Pinning and the Decay of Persistent Currents in Unsaturated Superfluid Helium Films," Preprint (September 1981). Also: Published in Physical Review B, Vol. 24, No. 1, 136-150 (January 1982).	NSF DMR80-07934
3325	J.M. Eggleston, G. Giuliani, and R.L. Byer, "Radial Intensity Filters Using Radial Birefringent Elements," Preprint (September 1981). Also: Published in Journal of the Optical Society of America, Vol. 71, No. 10, 1264-1272 (October 1981).	AFOSR-80-0144
3326	S. Doniach, "Quantum Fluctuations in Two-Dimensional Superconductors," Preprint (August 1981). Also: Published in Physical Review B, Vol. 24, No. 9, 5063-5070 (1 November 1981).	NSF DMR80-07934
3327	S. Froyen and C. Herring, "Distribution of Interatomic Spacings in Random Alloys," Reprint from Journal of Applied Physics, Vol. 52, No. 12, 7165-7173 (December 1981).	NSF DMR77-21384
3328	R.W. Falcone and K.D. Pedrotti, "Pulsed Hollow Cathode Discharge for XUV Lasers and Radiation Sources," Preprint (September 1981). Also: Published in Optics Letters, Vol. 7, No. 2, 74-76 (February 1982).	N00014-78-C-0403
3329	Staff, "Film Synthesis and New Superconductors," Interim Technical Report for the period 1 April to 30 September 1981 (October 1981).	F49620-78-C-0009
3330	M.D. Wright, "Laser Induced Charge Transfer Collisions," Internal Memorandum (September 1981).	F49620-80-C-0023

G.L. No.	Title	Contract/Grant
3331	Staff, "Tunable Optical Sources," Progress Report for the period 2 February to 30 June 1981 (September 1981).	DAAG29-81-K-0038
3332	L.-S. Lee and A.L. Schawlow, "A Multiple-Wedge Wavemeter for Pulsed Lasers," Preprint (October 1981). Also: Published in Optics Letters, Vol. 6, No. 12, 610-612 (December 1981).	NSF PHY78-23532
3333	Staff, "To Study the RF Properties of Superconducting A15 Compounds," Quarterly Progress Report for the period April to June 1981 (September 1981).	N00019-81-C-0131
3334	W.A. Harrison and J.M. Wills, "Interionic Interactions in Simple Metals," Preprint (October 1981). Also: Published in Physical Review B, Vol. 25, No. 8, 5007-5017 (15 April 1982).	NSF DMR80-22365
3335	J.R. Willison, R.W. Falcone, J.F. Young, and S.E. Harris, "Laser Spectroscopy of Metastable XUV Levels in Lithium Atoms and ions," Preprint (October 1981). Also: Published in Physical Review Letters, Vol. 47, No. 25, 1827-1829 (21 December 1981).	N00014-78-C-0403
3336	Staff, "Acoustic Microscopy at Cryogenic Temperatures," Status Report for the period 1 January to 1 July 1981 (September 1981).	N00014-77-C-0412
3337	A.F. Arbel and J.E. Bowers, "Active Matching of Interdigital Transducers," Preprint (October 1981). Also: Published in the 1981 Ultrasonics Symposium Proceedings, pp. 69-73.	N00014-76-C-0129

G.L. No.	Title	Contract/Grant
3338	R. Trebino, J.P. Roller, and A.E. Siegman, "A Comparison of the Casegrain and Other Beam Expanders in High-Power Pulsed Dye Lasers," Preprint (October 1981). To appear in the August 1982 issue of IEEE Journal of Quantum Electronics.	AFOSR-80-0145 and N00014-75-C-0632
3339	Staff, "Quantiative Modeling of Flaw Responses in Eddy Current Testing," 33rd Monthly Report for the period 1 September to 1 October 1981 (October 1981).	EPRI RP1395-3
3340	Staff, "PVF_2 Transducers for Non-destructive Evaluation of Ceramics and Brittle Materials," Final Report (October 1981).	AFOSR-77-3386
3341	Staff, "New Approach to Optical Systems for Inertial Rotation Sensing," Interim Scientific Report (December 1981).	F49620-80-C-0040
3342	H.A. Kunkel and B.A. Auld, "Laser Probe Investigation of Guided Acoustic Interface Waves in Differentially Poled Ceramics," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 438-443.	N00014-79-C-0222
3343	S.D. Bennett, D. Husson, and G.S. Kino, "Measurement of Three-Dimensional Stress Variation," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 964-968.	EPRI RP609-1
3344	A.R. Selfridge, R. Baer, B.T. Khuri-Yakub, and G.S. Kino, "Computer-Optimized Design of Quarter-Wave Acoustic Matching and Electrical Matching Networks for Acoustic Transducers," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 644-648.	NSF ECS-7728528, DOE DE-AM03-76SF00326 (DE-AT03-76ER71043)

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3345	D.V. Nelson and B.A. Auld, "Crack Opening Displacement as a Fracture Mechanics Parameter in Eddy Current NDE," Preprint (October 1981). Presented at the Review of Progress in Quantitative NDE at Boulder, CO.	Ames SC-81-011 and NSF DMR77-24222 (Stanford Materials Lab.)
3346	J.J. Tien, K. Liang, B.T. Khuri-Yakub, G.S. Kino, D. Marshall, and A.G. Evans, "Long Wavelength Measurement of Surface Cracks in Silicon Nitride," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 844-848.	N00014-78-C-0283
3347	K. Liang, B.T. Khuri-Yakub, and G.S. Kino, "Reflection Tomography at 50 and 300 MHz," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 925-929.	Ames SC-81-009 and F49620-79-C-0217
3348	D.K. Peterson, S.D. Bennett, and G.S. Kino, "Real-Time Digital Imaging," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 919-924.	F49620-79-C-0217
3349	R.L. Baer, A.R. Selfridge, B.T. Khuri-Yakub, G.S. Kino, and J. Souquet, "Contacting Transducers and Transducer Arrays for NDE," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 969-973.	F49620-79-C-0217 and DE-AT03-76ER71043
3350	R.L. Thornton, J.E. Bowers, and J.B. Green, "Recent Developments in the ZnO on Si Storage Correlator," Preprint (October 1981). Also: Published in 1981 Ultrasonics Symposium Proceedings, pp. 774-779.	N00014-76-C-0129

G.L. No.	Title	Contract/Grant
3351	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 55th Report for the period 1 August to 30 September 1981 (October 1981).	EPRI RP609-1
3352	S. Ayter, B.A. Auld, and M. Tan, "Optical Probing of Resonant Ultrasonic Scattering from Machined Flaws in Plates," Preprint (October 1981).	Ames SC-81-011 and NSF ENG79-14623
3353	B.A. Auld, F. Muennemann, M. Riaziat, and D.K. Winslow, "Analytical Methods in Eddy Current NDE," Preprint (October 1981).	Ames SC-81-011, EPRI RP1395-3, NSF DMR77-24222, and B-96062-B-K.
3354	R.L. Jungerman, J.E. Bowers, J.B. Green, and G.S. Kino, "Fiber Optic Laser Probe for Acoustic Wave Measurements," Preprint (November 1981). Also: Published in Applied Physics Letters, Vol. 40, No. 4, 313-315 (15 February 1982).	F49620-79-C-0217
3355	Staff, "Piezoelectric PVF_2 Polymer Films and Devices," Final Report (November 1981).	N00014-77-C-0582
3356	A.L. Schawlow, "Simplifying Spectra by Laser Level Labeling," Preprint (November 1981). Also: Published in Physica Scripta, Vol. 25, 333-337 (1982).	NSF PHY80-10689 and N00014-78-C-0403
3357	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 34th Monthly Report for the period 1 October to 1 November 1981 (November 1981).	EPRI RP1395-3
3358	G.P. Morgan, H.-R. Xia, and A.L. Schawlow, "Spectral Structure of CW Two-Photon Transitions in Na_2," Preprint (November 1981). Also: Published in the Journal of the Optical Society of America, Vol. 72, No. 3, 315-320 (March 1982).	NSF PHY80-10689 and N00014-78-C-0403

G.L. No.	Title	Contract/Grant
3359	A.E. Siegman, "Developments in Mode-Locked Lasers and their Applications," Preprint (December 1981). To be published in SPIE.	AFOSR-80-0145 and NASA NAG 2-44
3360	J.J. Tien, B.T. Khuri-Yakub, G.S. Kino, A.G. Evans, and D. Marshall, "Long Wavelength Measurements of Surface Cracks in Silicon Nitride," Preprint (December 1981). To be published in Review of Progress in Quantitative Nondestructive Evaluation, Vol. 1, pp. 577-580.	N00014-78-C-0283
3361	D.K. Peterson, R. Baer, K. Liang, S.D. Bennett, B.T. Khuri-Yakub, and G.S. Kino, "Quantitative Evaluation of Real-Time Synthetic Aperture Acoustic Images," Preprint (December 1981). To be published in Review of Progress in Quantitative Nondestructive Evaluation, Volume 1, pp. 777-786.	F49620-79-C-0217
3362	B.T. Khuri-Yakub, G.S. Kino, K. Liang, J. Tien, C.H. Chou, A.G. Evans, and D. Marshall, "Nondestructive Evaluation of Ceramics," Preprint (December 1981).	Ames SC-81-009 and N00014-78-C-0283
3363	Staff, "Research on Nondestructive Testing," Year End Report for the period 1 September 1980 through 31 August 1981 (November 1981).	F49620-79-C-0217
3364	R.L. Byer, "Nd:YAG Pumped Tunable Sources and Applications," Internal Memorandum (November 1981).	--------
3365	Staff, "Acoustic Microscopy for Nondestructive Evaluation of Materials," Final Technical Report for the period 1 July 1978 through 31 December 1981 (December 1981).	F49620-78-C-0098
3366	S.A. Newton, J.E. Bowers, and H.J. Shaw, "Single Mode Fiber Recirculating Delay Line," Preprint (December 1981).	F49620-80-C-0040

G.L. No.	Title	Contract/Grant
3367	R.A. Bergh, M.J.F. Digonnet, H.C. Lefevre, S.A. Newton, and H.J. Shaw, "Single Mode Fiber Optic Components," Preprint (December 1981).	N00014-75-C-0632 and Atlantic Richfield Co.
3368	Staff, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," 35th Monthly Report for the period 1 November to 1 December 1981 (December 1981).	EPRI RP1395-3
3369	Staff, "Acoustic Microscopy at Cryogenic Temperature," Annual Summary Report for the period 1 July 1980 through 30 June 1981 (November 1981).	N00014-77-C-0412
3370	D. Rugar, "Cryogenic Acoustic Microscopy," Internal Memorandum (December 1981).	N00014-77-C-0412
3371	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 57th Report for the period 1 October to 30 November 1981 (December 1981).	EPRI RP609-1
3372	H. Gerhardt and T.W. Hänsch, "Color Center Laser and Electron Impact Excitation: Doppler-Free Spectroscopy in Excited Helium States," Preprint (December 1981). Also: Published in Optics Communications, Vol. 41, No. 1, 17-20 (1 March 1982).	NSF PHY80-10689 and N00014-78-C-0403
3373	D.K. Peterson, S.D. Bennett, and G.S. Kino, "Real-Time NDE of Flaws Using a Digital Acoustic Imaging System," Preprint (January 1982).	F49620-79-C-0217
3374	D.C. Wolfe, Jr. and R.L. Byer, "Model Studies of Laser Absorption Computed Tomography for Remote Air Pollution Measurement," Preprint (December 1981). Also: Published in Applied Optics, Vol. 12, No. 7, 1165-1178 (1 April 1982).	NASA NSG 2289 and F49620-77-C-0092

G.L. No.	Title	Contract/Grant
3375	Staff, "Research to Define Algorithms Appropriate to a High Data Rate Laser Wavelength Measurement Instrument," Final Report (December 1981).	LLL 3488009
3376	B.A. Auld and M. Riaziat, "Quantitative Modeling of Flaw Responses in Eddy Current Testing," Final Report December 1981).	EPRI RP 1395-3
3377	Staff, "Acoustically Scanned Optical Imaging Devices," Management Report for the period 1 October to 31 December 1981 (January 1982).	N00014-76-C-0129
3378	Staff, "Acoustically Scanning of Optical Images," Semiannual Technical Report No. 13 for the period 1 July through 31 December 1981 (January 1982).	N00014-76-C-0129
3379	Staff, Research Studies on Radiative Collisional Processes," Annual Technical Report for the period 1 October 1980 through 30 September 1981 (January 1982).	F49620-80-C-0023
3380	Staff, "Reseach Studies on Radiative Collisional Processes," Semiannual Progress Report for the period 1 July through 31 December 1981 (January 1982).	F49620-80-C-0023
3381	Staff, "Elastic Domain Wall Waves in Ferroelectric Ceramics and Single Crystals," Annual Progress Report for the period 1 February 1981 to 31 January 1982 (January 1982).	N00014-79-C-0222
3382	J.E. Bowers, S.A. Newton, W.V. Sorin, and H.J. Shaw, "Filter Response of Single Mode Fiber Recirculating Delay Lines," Preprint (January 1982). Also: Published in Electronics Letters, Vol. 18, No. 3, 110-111 (4 February 1982).	ARCO Ventures

G.L. No.	Title	Contract/Grant
3383	Staff, "Tunable Optical Sources," Progress Report for the period 30 June through 31 December 1981 (January 1982).	DAAG29-81-K-0038
3384	D. Husson and G.S. Kino, "A Perturbation Theory for Acoustoelastic Effects," Preprint (March 1982). To appear in Journal of Applied Physics.	EPRI RP609-1
3385	Staff, "Acoustic Techniques for Measuring Stress Regions in Materials," 58th Report for the period 1 December 1981 through 31 January 1982 (February 1982).	EPRI RP609-1
3386	J.E. Bowers, "All-Fiber Sensor for Surface Acoustic Waves," Preprint (March 1982). Submitted to Applied Physics Letters.	ARCO Ventures
3387	J.F. Young, S.E. Harris, P.J.K. Wisoff, and A.J. Mendelsohn, "Microwave Excitation of Excimer Lasers," Preprint (February 1982). Also; Published in Laser Focus, 63-67 (April 1982).	F49620-80-C-0023
3388	Staff, "Acoustic Microscopy at Cryogenic Tempeatures," Status Report for the period 1 July 1981 to 1 January 1982 (January 1982).	N00014-77-C-0412
3389	B.A. Auld, A. Renard, and J. Henaff, "STW Resonances on Corrugated Plates of Finite Thickness," Preprint (January 1982). Also: Published in Electronics Letters, Vol. 18, No. 3, 183-184 (18 February 1982).	---------
3390	Staff, "Film Synthesis and New Superconductors," Interim Technical Report for the period 1 October 1981 through March 1982 (March 1982).	F49620-78-C-0009

G.L. No.	Title	Contract/Grant
3391	P.M. Fauchet and A.E. Siegman, "Surface Ripples on Silicon and Gallium Arsenide Under Picosecond Laser Illumination," Preprint (February 1982). To appear in Applied Physics Letters.	AFOSR-80-0145
3392	J.A. Hildebrand, D. Rugar, and C.F. Quate, "Biological Acoustic Microscopy Living Cells at 37°C and Fixed Cells in Cryogenic Liquids," Preprint (March 1982). To appear in the EMSA Proceedings.	NIH 5 R01 GM-25826-04
3393	M.J.F. Digonnet and H.J. Shaw, "Single Mode Fiber Optic Wavelength Multiplexer," Preprint (February 1982). To be presented at the 1982 Topical Meeting on Optical Fiber Communication at Phoenix, Arizona, April 12-14, 1982.	ARCO Ventures
3394	(Ask Ingrid for this report)	
3395	G.A. Pavlath and H.J. Shaw, "Re-Entrant Fiber Optic Rotation Sensors," Preprint (February 1982). Presented at the International Conference on Fiber-optic Rotation Sensors, held in November 1981 at MIT.	F49620-80-C-0040
3396	R.D. Feldman and B.E. Jacobson, "Growth Morphology of Superconducting Nb-Si: The Effects of Oxygen and Substrate Temperature," Preprint (February 1982). To appear in the Journal of Low Temperature Physics.	F49620-78-C-0009
3397	W.A. Harrison, "Theoretical Alchemy, Fresh Insight into Chemical Bonding can be Obtained by Conceptually Transmuting One Nucleus into Another," Preprint (February 1982). Submitted to the American Journal of Physics.	NSF DMR77-22365
3398	H.J. Arditty and H.C. Lefevre, "Theoretical Basis of Sagnac Effect in Fiber Gyroscopes," Preprint (February 1982). Presented at the International Conference on Fiber-optics Rotation Sensors held in November 1981 at MIT.	ARCO Ventures

G.L. No.	Title	Contract/Grant
3399	L.A. Bloomfield, B. Couillaud, Ph. Dabkiewicz, H. Gerhardt, and T.W. Hansch, "Hyperfine Structure of the 2^3S - S^3P Transition in ^3He by High Resolution UV-Laser Spectroscopy," Preprint (March 1982). Submitted to Physical Review A, Rapid Communication.	NSF PHY80-10689 and N00014-78-C-0403
3400	R.A. Bergh, H.C. Lefevre, and H.J. Shaw, "Compensation of the Optical Kerr Effect in Fiber Optic Gyroscopes," Preprint (March 1982). Submitted to Optics Letters.	ARCO Ventures
3401	(Get information from Ingrid)	
3402	J.B. Green and G.S. Kino, "SAW Convolvers Using Focused Interdigital Transducers," Preprint (March 1982). Submitted to IEEE Transactions on Sonics and Ultrasonics.	N00014-75-C-0632
3403	Staff, "Probe-Flaw Interactions and Inversion Processes," Interim Report for the period 1 October 1981 through 31 March 1982 (March 1982).	Ames SC-81-011

G.L. No.	Title	Con... ct/Grant
3391	P.M. Fauchet and A.E. Siegman, "Surface Ripples on Silicon and Gallium Arsenide Under Picosecond Laser Illumination," Preprint (February 1982). To appear in Applied Physics Letters.	AFOSR-80-0145
3392	J.A. Hildebrand, D. Rugar, and C.F. Quate, "Biological Acoustic Microscopy Living Cells at 37°C and Fixed Cells in Cryogenic Liquids," Preprint (March 1982). To appear in the EMSA Proceedings.	NIH 5 R01 GM-25826-04
3393	M.J.F. Digonnet and H.J. Shaw, "Single Mode Fiber Optic Wavelength Multiplexer," Preprint (February 1982). To be presented at the 1982 Topical Meeting on Optical Fiber Communication at Phoenix, Arizona, April 12-14, 1982.	ARCO Ventures
3394	M.R. Beasley, "Small-Scale Superconductive Devices M320/0968," Preprint (February 1982). Submitted to the Encyclopaedia of Material Science and Engineering.	-----
3395	G.A. Pavlath and H.J. Shaw, "Re-Entrant Fiber Optic Rotation Sensors," Preprint (February 1982). Presented at the International Conference on Fiber-optic Rotation Sensors, held in November 1981 at MIT.	F49620-80-C-0040
3396	R.D. Feldman and B.E. Jacobson, "Growth Morphology of Superconducting Nb-Si: The Effects of Oxygen and Substrate Temperature," Preprint (February 1982). To appear in the Journal of Low Temperature Physics.	F49620-78-C-0009
3397	W.A. Harrison, "Theoretical Alchemy, Fresh Insight into Chemical Bonding can be Obtained by Conceptually Transmuting One Nucleus into Another," Preprint (February 1982). Submitted to the American Journal of Physics.	NSF DMR77-22365

G.L. No.	Title	Contract/Grant
3398	H.J. Arditty and H.C. Lefevre, "Theoretical Basis of Sagnac Effect in Fiber Gyroscopes," Preprint (February 1982). Presented at the International Conference on Fiber-optics Rotation Sensors held in November 1981 at MIT.	ARCO Ventures
3399	L.A. Bloomfield, B. Couillaud, Ph. Dabkiewicz, H. Gerhardt, and T.W. Hansch, "Hyperfine Structure of the 2^3S - S^3P Transition in ^3He by High Resolution UV-Laser Spectroscopy," Preprint (March 1982). Submitted to Physical Review A, Rapid Communication.	NSF PHY80-10689 and N00014-78-C-0403
3400	R.A. Bergh, H.C. Lefevre, and H.J. Shaw, "Compensation of the Optical Kerr Effect in Fiber Optic Gyroscopes," Preprint (March 1982). Submitted to Optics Letters.	ARCO Ventures
3401	T.H. Geballe, "This Golden Age of Solid State Physics," Preprint (March 1982). Submitted for inclusion in the 50th Anniversary Issue of Physics Today.	-----
3402	J.B. Green and G.S. Kino, "SAW Convolvers Using Focused Interdigital Transducers," Preprint (March 1982). Submitted to IEEE Transactions on Sonics and Ultrasonics.	N00014-75-C-0632
3403	Staff, "Probe-Flaw Interactions and Inversion Processes," Interim Report for the period 1 October 1981 through 31 March 1982 (March 1982).	Ames SC-81-011

SECTION VI

LABORATORY CONTRACT AND GRANT SUPPORT

(Edward L. Ginzton Laboratory)

SOURCE - CONTRACT-GRANT NO.	P.I.	TITLE	ANNUAL RATE as of 4/1/82	EXPIRATION DATE as of 4/1/82
1. Air Force Office of Scientific Research				
F49620-78-C-0009	Geballe	Film Synthesis and New Superconductors	$370,723	9/30/82
F49620-79-C-0217	Kino	Research on Nondestructive Evaluation	268,353	8/31/83
F49620-80-C-0023	Harris/Young	Research Studies on Radiative Collisional Processes	271,240	9/30/82
F49620-80-0091	Hanson/Byer	Advanced Instrumentation and Diagnostics for Chemically Reacting Flows	72,200	9/30/82
F49620-81-C-0047	Byer	Laser Physics and Spectroscopy	179,754	3/14/83
F49620-82-K-0015	Siegman	Laser Physics and Laser Techniques	181,983	1/31/84
2. Army Research Office				
DAAG29-81-K-0038	Byer	Tunable Optical Sources	261,628	2/19/84
3. Electric Power Research Institute				
RP1395-3	Auld	Quantative Modeling of Flaw Responses in Edy Current Testing	15,001	12/31/82
T107-5-5	Kino	Acoustic Techniques for Measuring Stress Regions in Materials	217,406	12/31/83
4. Industrial Contracts				
General Motors RS-875177	Byer	High Resolution Combustion Diagnostic Studies	25,674	5/31/82
Litton Systems Inc.	Shaw	Research on Fiber Optic Directional Couplers	748,000	12/31/83
5. National Aeronautics and Space Administration				
NAG 1-182	Byer	High Energy Efficient Solid State Laser Sources	50,357	5/31/82
NAG 2-44	Harris/Siegman/Young	Studies on Lasers and Laser Devices	80,000	3/31/83
NAG 5-220	Byer/Feigelson	Growth and Evaluation of Crystals for Infrared Non-linear Applications	50,155	1/31/83
NCC-2-50	Byer	Ultra High Resolution Molecular Beam CARS Spectroscopy With Applications to Planetary Atmospheric Molecules	30,000	6/30/82
NCC 2-120	Geballe	Investigation of the Properties of Doped Silicon on Sapphire for Far Infrared Bolometers	35,421	8/2/82

SOURCE - CONTRACT-GRANT NO.	P.I.	TITLE	ANNUAL RATE as of 4/1/82	EXPIRATION DATE as of 4/1/82
6. National Institutes of Health				
NIH 5-R01-GM25217-05	Doniach	X-ray Spectroscopy of $Ca2^{+}$ Ions in Biological Systems	$69,093	3/31/83
NIH 5-R01-GM25826-04	Quate	Acoustic Microscopy for Bio-medical Applications	158,907	11/30/82
7. National Science Foundation				
NSF DMR-8007934	Doniach	Theory of Cooperative Phenomena in Superfluid Systems of Reduced Dimensionality	33,500	6/30/82
NSF DMR-8022365	Harrison/Herring	Pseudopotential Methods in Physics	61,800	12/14/82
NSF DMR-8109583	Beasley	Two-Dimensional Superconductivity and Layered Superconducting Structures	67,000	6/30/82
NSF ECS-7912673	Byer	Molecular Beam CARS Spectroscopy	63,275	11/30/82
NSF ECS-8010786	Quate	Research on Acoustic Microscopy With Superior Resolution	120,000	1/31/83
NSF PHY-8010689	Schawlow/Hansch	Spectroscopy and Quantum Electronics	375,500	5/31/82
8. Navy				
N00014-75-C-0632	Siegman/Beasley	Optical and Acoustic Wave Research (JSEP)	404,078	3/31/82
N00014-76-C-0129	Kino	Acoustical Scanning of Optical Images	131,129	11/14/83
N00014-77-C-0412	Quate	Acoustic Microscopy at Cryogenic Temperatures	99,091	6/30/82
N00014-78-C-0283	Kino	Measurements of Surface Defects in Ceramics	70,000	4/30/82
N00014-78-C-0403	Schawlow/Hansch	Advanced Laser Source Research	300,000	3/31/82
N00014-79-C-0222	Auld	Elastic Domain Wall Waves in Ferroelectric Ceramics and Single Crystals	47,003	1/31/85
N00014-81-K-0469	Doniach/Hodgson	Small X-ray Defraction of Immuno-globulin-Membrane Complexes	65,835	4/14/83
N00019-81 C-0131	Beasley/Geballe	RF Properties of Superconducting A-15 Compounds	23,050	6/30/82
9. Department of Energy				
DE-AT03-76ER71043	Beasley	Superconducting and Semiconducting Properties of Electron Beam Evaporated Materials	153,931	1/31/83
DE-AT03-81ER10865	Kino	High Frequency Transducers	88,000	3/31/84

SOURCE - CONTRACT-GRANT NO.	P.I.	TITLE	ANNUAL RATE as of 4/1/82	EXPIRATION DATE as of 4/1/82
10. Subcontracts				
Ames Science Laboratory SC-11-009	Kino	Bulk Wave NDE of Structural Ceramics	$80,000	9/30/82
Ames Science Laboratory SC-11-011	Auld	Quantative Surface Flaw Characteristics	90,000	9/30/82
Battelle Industries B-96062-B-K	Auld	Design of a Novel Eddy-Current Probe	35,105	9/29/82
Lawrence Livermore Laboratory 3818301	Byer	Improved Solid State Laser Sources	74,095	6/1/82

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by Block no.)

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Acoustics	Weak link Josephson Junctions	Nonlinear elasticity in ferroic materials	SAWFET
Optical Imaging	Nonlinear Optical Studies	Single Crystal Optical Fibers	SQUID's
Fast electronics	Time-resolved measurements of lattice properties		SNS
Quantum electronics	High T_c superconducting Weak-Link Josephson Junctions		SSemiS

20. ABSTRACT (Continue on reverse side if necessary and identify by Block no.)

This report summarizes the research progress and activity on Joint Services Electronics Program Contract No. N00014-75-C-0632 for the period 1 April 1981 through 31 March 1982. Specific Projects are: (81-1) Interaction of Acoustic and Optical Waves with Domains in Ferroic Fibers with Bulk Materials: (B. A. Auld); (81-2) High T_c Josephson Junctions & Circuits (M. R. Beasley); (81-3) Optical & Nonlinear Optical Studies of Single Crystal Fibers (R. L. Byer); (81-4) Acoustic Surface Wave Scanning of Optical Images. (G. S. Kino); (81-5) Picosecond Raman Studies of Electronic Solids (A. E. Siegman).

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